World Gastroenterology Organisation Global Guideline

Obesity

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1 General aspects

1.1 Definitions

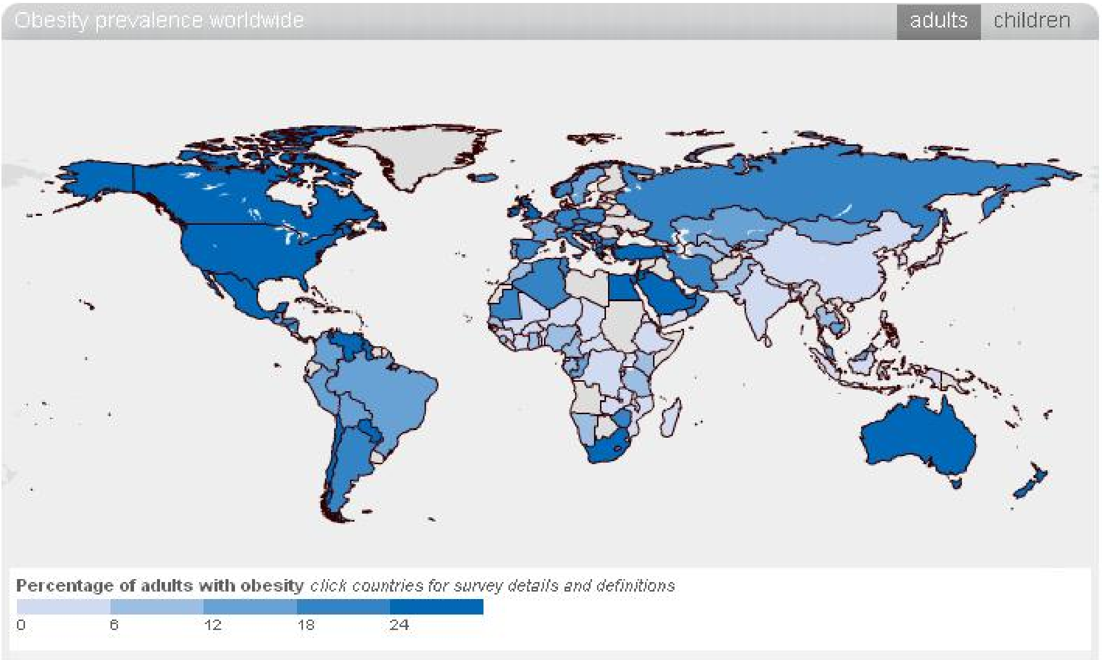
- Body mass index (BMI): weight (in kilograms) divided by the square of the individual's height (in meters).
- The International Obesity Task Force (IOTF) definition of obesity (based on Caucasians with a "Western" lifestyle) sets cut-off points of 25 kg/m^2 for adult excess weight and 30 kg/m^2 for obesity. These BMI cut-off points are considered to have a more international basis than other definitions.
- The BMI index ranges for children and teenagers should take the normal differences in body fat between boys and girls and differences in body fat at various ages into account:
  U.S. Centers for Disease Control and Prevention (CDC) definition:
  — BMI ≥ 95th percentile for age = "overweight"
  — BMI between the 85th and 95th percentiles = "at risk of overweight"
  European Childhood Obesity Group classification:
  — BMI ≥ 85th percentile for age = "overweight"
  — BMI ≥ 95th percentile for age = "obesity"

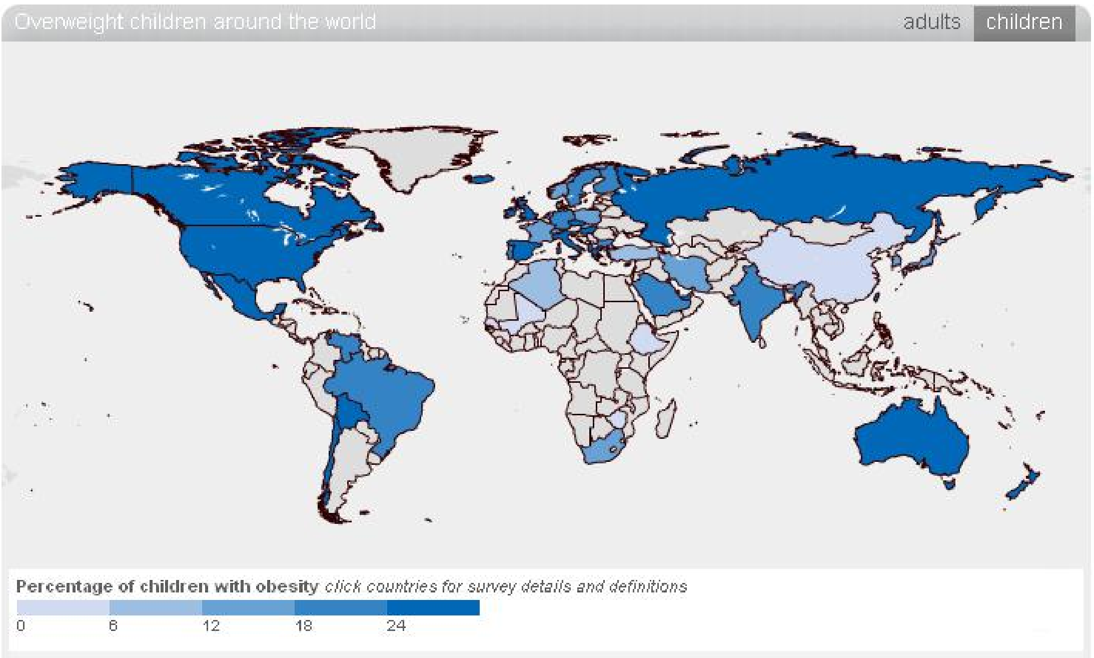
1.2 Key management points

- Diet and lifestyle modification, with or without medications, is the first step; if this fails, then surgery should be considered.
- The first treatment step is the basis for every subsequent step and consists of a diet, a less sedentary lifestyle, exercise, and behavioral modification. If weight loss of 5–10% is not achieved within 6 months, the next step is the same basic treatment combined with medication. The last step is again a diet, a less sedentary lifestyle, exercise, and behavioral modification, but now combined with bariatric surgery.
- Obesity requires long-term care, and it is important that management should be provided in a multidisciplinary environment with support from physicians, medical specialists (internists), dieticians, surgeons, psychologists and physiotherapists.
- Providing education and information for children may be the best and least costly way of controlling obesity in the longer term.

1.3 The global picture

The maps below show the percentages of adults and children with obesity worldwide. The statistics for each country can be viewed by visiting the International Association for the Study of Obesity's web site (http://www.iaso.org/publications/world-map-obesity/) and holding the mouse cursor over any country.





1.3.1 Epidemiology

Table **1** Global epidemiology, 2005–2015

2015	The World Health Organization (WHO) projects that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese.
2008	A report in the *Journal of the American Medical Association* (*JAMA*) shows that overall, in 2003–2006: • 11.3% of children and adolescents aged 2–19 years were at or above the 97th percentile of the 2000 BMI-for-age growth charts (extreme obesity).

	• 16.3% were at or above the 95th percentile (obese).
	• 31.9% were at or above the 85th percentile (overweight).
	• Prevalence estimates varied by age and by ethnic group.
	• Analyses of the trends in high BMI for age showed no statistically significant trend over four periods studied (1999–2000, 2001–2002, 2003–2004, and 2005–2006), for either boys or girls.
	Today, the mean BMI has increased and the most obese individuals have become much more obese, so that the curve of the normal distribution has shifted to the right.
2005	• WHO data show that in 2005, approximately 1.6 billion adults (aged 15 or over) were overweight and that at least 400 million adults were obese.
	• At least 20 million children under the age of 5 years were overweight globally in 2005.
	• Obesity has become an epidemic condition.
	• In the United States, obesity among adults increased from 15.3% in 1995 to 23.9% in 2005.

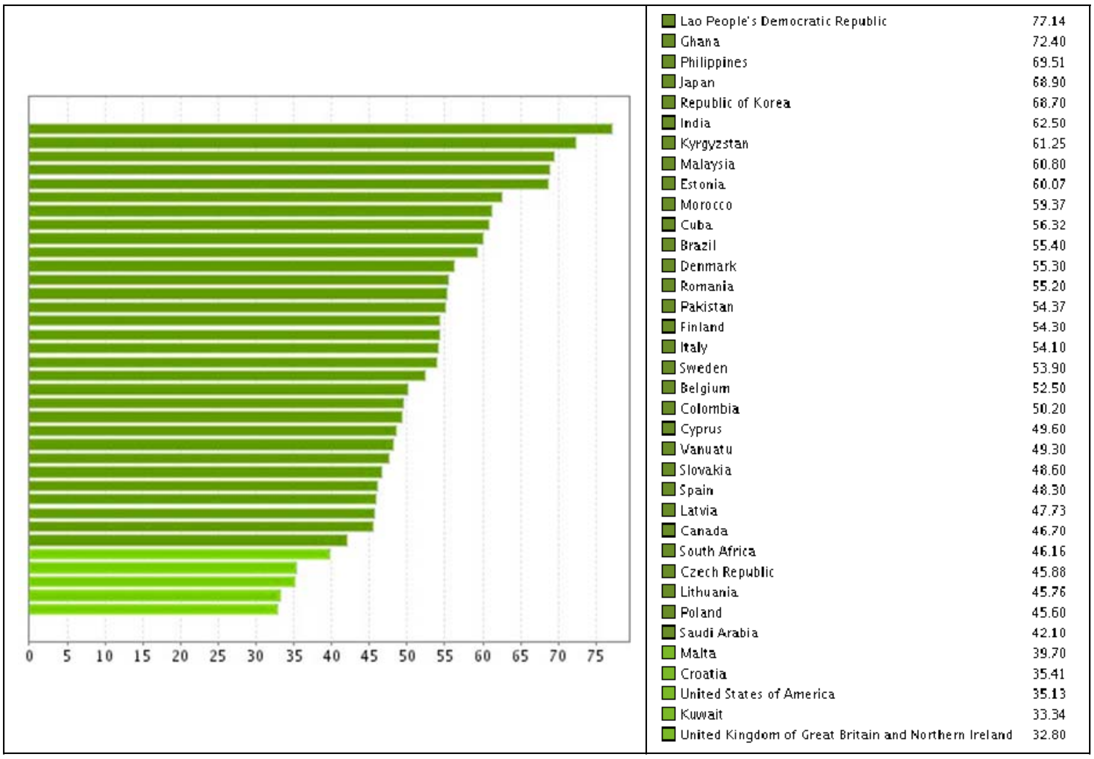
1.3.2 Prevalence of obesity in the elderly

The prevalence of obesity is rising progressively, even among older age groups. On the basis of the National Health Examination Survey (NHES) I and National Health and Nutrition Examination Study (NHANES) I–III, it was estimated that the prevalence of obesity (BMI $\geq$ 30 kg/m^2) in elderly Americans aged 60 or over would increase from 23.6% in 1990 and 32.0% in 2000 to 37.4% in 2010 (ranging from 33.6% in the best-case estimate, based on the lowest increase in prevalence of 0.1%, to 39.6% in the worst-case estimate, based on continuation of the present increase of 7%). This signifies an increase in the number of obese older adults from 9.9 million (1990) and 14.6 million (2000) to 20.9 million in 2010 (range 18.0–22.2 million). It is at present unclear whether these projections will be borne out.

The prevalence of obesity in nursing homes is also an escalating problem. Almost 30% of U.S. nursing homes have reported that 15–20% of their residents are obese. Evidence suggests that obesity and weight gain increase the relative risk of nursing-home admission for community-dwelling older adults. For those aged 65–74, the risk of admission increased by 31%. Those who were overweight and experienced a significant weight gain were 2.13 times more likely to be admitted to a nursing home.

In Europe, the prevalence of obesity increases with age to a peak at about 60 years. Thereafter, body weights change little and begin to decline in older age groups. However, current long-term trends indicate that the prevalence of obesity will increase.

Fig. **1** Body mass index (BMI) data by country: percentages of adults with a normal BMI



1.3.3 A problem in developing countries?

Once considered a problem only in high-income countries, excess weight and obesity are now dramatically increasing in low-income and middle-income countries as well, particularly in urban settings, according to the World Health Organization (WHO).

In developing countries, the prevalence of chronic or noncommunicable diseases (such as hypertension, diabetes, and cardiovascular disease) is rising much more rapidly than in the industrialized world. Although the problem of childhood malnutrition is far from having been solved, the new pandemic of obesity and its accompanying noncommunicable diseases are challenging organizations such as the WHO.

Although it is now well recognized that chronic diseases are a growing problem for low-income and middle-income countries, limited data are available for these countries and the developing world has been largely ignored in health strategies.

In a recent systematic review, the highest prevalences of childhood excess weight were found in Eastern Europe and the Middle East, while India and Sri Lanka had the lowest prevalence. Studies in developing countries showed a considerable prevalence of metabolic syndrome in adolescents. Developing countries are facing an increasing incidence of childhood obesity and new cases of metabolic syndrome among children. In the near future, this is likely to create a huge socioeconomic and public health burden for poorer nations. The WHO has warned that projected numbers of new cases of diabetes may run into the hundreds of millions within the next two decades.

The globalization process may exacerbate the uneven dietary development between rich and poor: while high-income groups in developing countries enjoy the benefits of a more dynamic marketplace, lower-income groups may experience convergence towards poor-quality diets. Many developing countries are in a "nutrition transition" phase, evident in the rapid rise in obesity and diet-related chronic diseases throughout the world. Although developing countries are still struggling with malnutrition and micronutrient deficiencies, the consumption of foods high in fats and sugars in these countries is increasing. This transition is rooted in the globalization processes that are affecting the nature of agricultural and food systems and altering the quantity, type, cost, and desirability of foods available for consumption. The integration of the global marketplace is affecting specific diet patterns, especially in middle-income countries, as a result of:

- Greater consumption of vegetable oil, made possible by agricultural production and trade policies
- Greater consumption of highly processed foods, facilitated by policies on foreign direct investment and global food marketing

Some of the structural causes of obesity and diet-related chronic diseases throughout the world can be addressed through global food and health policies—especially in groups with low socioeconomic status.

According to the WHO, many low-income and middle-income countries are now facing a “double burden” of disease:

- While still dealing with infectious diseases and undernutrition, they are at the same time facing a rapid upsurge in chronic disease risk factors such as obesity and excess weight.
- Undernutrition and obesity can now be found existing side by side within the same country, the same community, and even within the same household.
- This double burden is caused by inadequate nutrition in the prenatal period and in infants and young children, followed by exposure to high-fat, energy-dense, micronutrient-poor foods and a lack of physical activity.

2 Management

2.1 Management of obesity

- Ensure optimal medical care for patients who are obese:
  — Educate staff about treating patients with respect.
  — Offer obese patients the same level of care as nonobese patients, providing general preventive services and monitoring and treating ongoing medical conditions.
- Encourage healthy behavior and self-acceptance, even in the absence of weight loss:
  — Record weight without comments.
  — Ask patients if they wish to discuss their weight or health.
  — Review barriers among health-care providers—e.g., the perception that obesity is mainly due to the patient’s lack of willpower.
- Determine the obesity class—the level of excess weight:
  — Assess overall fatness and central adiposity.
  — Calculate BMI and measure waist circumference.
- Assess comorbidities and risk status.
- Is weight loss indicated?
  — Prevent (further) weight gain.

— Prevent the complications of obesity.
— The goal is to favorably influence coexisting conditions associated with obesity by reducing excess weight, maintaining a lower body weight, and controlling associated risk factors.
— What is the recommended minimum weight loss?
— Assess the patient's expectations.

- Evaluation of the patient's readiness:
  — Reasons and motivation for weight loss.
  — Previous attempts at weight loss.
  — Support expected from family and friends.
  — Understanding of risks and benefits.
  — Attitudes toward physical activity.
  — Time availability.
  — Potential barriers to the patient's adoption of change.
  — Discuss the patient's preferences regarding diet and physical activity.
- Decide which treatment or combination of treatments is best:
  — Which diet should be recommended?
  — Discuss a physical activity goal.
- Is the patient a candidate for surgery?
  — BMI of 40 or higher.
  — BMI of 35 or higher, with comorbidities.
  — Severe sleep apnea.
  — Obesity-related cardiomyopathy.
  — Severe diabetes mellitus.
  — Severe joint disease.
  — Failure of medical weight control. Patients should have made previous attempts to lose weight.
  — Absence of medical or psychological contraindications.
  — No risks, or acceptable risks, for surgery.
  — The patient should receive full information about the anticipated risks and results of the operation, understand the procedure and its risks, and be strongly motivated to comply with the postsurgical regimen.
  — Medical and surgical care should be provided by a multispecialty team with experience in bariatric surgery and in perioperative and follow-up care.
  Note: Different countries use different BMI levels as indications for surgery: in the United States, the levels are 35 and 30; in continental Europe, the figures are 40 and 35. The United Kingdom guideline published by the National Institute for Health and Clinical Excellence (NICE) is very conservative, with a BMI > 50 required for surgery.
- Consider Orlistat weight-loss medication:
  — Combine with daily multivitamin treatment (due to possible malabsorption of fat-soluble vitamins). Inform the patient about side effects. There are two forms: Orlistat 3 × 120 mg (Xenical or Zerucal) or 3 × 60 mg daily.
- Manage coexisting conditions:
  — Hypertension: lower elevated blood pressure.
  — Type 2 diabetes: lower elevated blood glucose levels
- Dyslipidemia:
  — Lower elevated levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides.

— Raise low levels of high-density lipoprotein (HDL) cholesterol by encouraging physical exercise.

- Discuss strategies for weight maintenance.
- Encourage the patient to set realistic goals.
- Record keeping has been shown to be one of the most successful behavioral techniques for weight loss and maintenance. The patient should:
  — Record food intake and energy expenditure.
  — Keep track of body weight (at least once a week).
- Use fat-reduced, fiber-enriched diets. Consider adding protein-rich and low glycemic index diets for weight maintenance.
- Expand physical activity in line with the current fitness level and obesity-associated conditions:
  — Walking
  — Joining a gym
  — Developing a home-based program of aerobic and resistance training.

2.2 Treatment outcome

General. A 5–10% reduction in weight may be sufficient for favorable modification of waist circumference, blood pressure, circulating cytokines, and (variably) fasting levels of glucose, triglycerides, and HDL cholesterol. This applies to individuals with a BMI of up to 40 and has been confirmed by many studies. At BMI levels above 40, a 20–25% weight loss is recommended, although without much evidence.

- A change in the treatment regimen should be considered if weight loss is less than 5% in the first 6 months.
- Willingness to achieve weight reduction is important in predicting success.

Lifestyle intervention. Studies have shown that in comparison with standard care, lifestyle intervention:

- Significantly reduces body weight and cardiovascular risk factors.
- Has favorable effects, which are maintained for up to 3 years.

Physical activity without a reduced calorie intake leads to limited weight loss results.

Treatment combinations. Dietary and lifestyle interventions, along with pharmacologic weight loss treatment, provide modest weight loss and may improve markers of cardiovascular risk factors, although these benefits occur mainly in patients with cardiovascular risks.

2.3 Maintenance of weight reduction

The body has multiple mechanisms for modifying the energy balance to reestablish the original body weight. Weight loss induces a reduction in energy expenditure, hindering maintenance of weight loss. Failure to maintain weight loss is a common problem.

While short-term weight loss depends on caloric restriction, maintenance of weight loss mostly depends on the level of physical activity. For most people, long-term success is still difficult to achieve, and current therapies for obesity do not provide sufficient support for patients in adhering to the required lifestyle changes.

Predictive factors for maintaining weight loss include:

- Eating a low-fat, fiber-enriched, protein-rich diet.
- Frequent self-monitoring of body weight and food intake.
- High levels of physical activity.
- Long-term patient–provider contact.
- An initial greater weight loss during the active weight loss phase predicts a better weight maintenance thereafter.
- Weight loss of more than 2 kg in 4 weeks.
- Frequent/regular attendance at a weight loss program.
- Patient's belief that body weight can be controlled.
- Behavioral interventions (may be helpful).

Protective factors against regaining weight: expending about 2500 kcal/week, through:

- Moderate activity for approximately 80 min/day (brisk walking)
- Or vigorous activity for 35 min/day (jogging)

Treatment and support options:

- Primary-care setting
- Commercial programs
- Internet-based weight maintenance programs

2.4 Risks of weight loss

Some studies have concluded that intentional weight loss reduces mortality, whereas unintentional weight loss is associated with an increased risk of mortality.

Due to an increased flux of cholesterol through the biliary system, weight loss may increase the chances of cholelithiasis developing. Diets with moderate amounts of fat that trigger gallbladder contraction may reduce this risk. Slow weight loss—e.g., 0.5–1.0 kg/week—has been shown to prevent the formation of gallstones in patients with higher weight loss rates. Weight loss with adjustable gastric bands is associated with an incidence of gallstone formation that is no different from that in the normal population.

3 Obesity in the elderly

3.1 Introduction

There has been a rapid and continuing increase in life expectancy in most countries. By the year 2030, 20% of the adult U.S. population will be over the age of 65 and in Europe roughly two active people (aged 15–65) will be caring for one inactive older person. This increase in life expectancy has not necessarily meant an increase in healthy life years, but rather extra years of illness risk. This, together with the epidemic of obesity, which is showing an upward shift into older age groups, signifies a double disease burden in the near future. A detailed discussion of the available evidence on obesity and the elderly is available in the hyperlinked Appendix 5 below.

3.2 Health consequences of obesity in the elderly

It is far from clear which parameter may best predict poor health and a poor outcome with obesity in the elderly.

A slightly higher BMI value associated with a lower relative mortality in older compared with younger adults does not mean that obesity is not as harmful in the elderly. BMI may be a less appropriate index in the elderly. It should also be realized that although the relative risk of mortality and decreased survival appear to decline at ages above 59, the absolute mortality risk increases with increasing BMI up to age 75.

There are many confounding factors that contribute to underestimation of the health risks of obesity in the elderly. Among these are the survival effect (the presence of "resistant" survivors in whom the relation between BMI and mortality is lost), competing mortalities, relatively shortened life expectancy in old age, and the importance of age of onset and duration of obesity, as those who have become obese in old age may die before the adverse effects of obesity become apparent. In addition, smoking, weight change (weight gain and weight loss may be more detrimental than a stable weight) and unintentional weight loss may confound the estimation of health risks.

Medical complications of obesity in the elderly are mainly associated with metabolic syndrome (with glucose intolerance, hypertension, dyslipidemia, and cardiovascular disease). Metabolic syndrome peaks at age 50–70 in males and age 60–80 in females, with an odds ratio (OR) of 5.8 in 65-year-old males and 4.9 in 65-year-old females in comparison with 20–34-year-old individuals.

Other obesity-related disorders are (osteo)arthritis (with an OR of 4.8 for males and 4.0 for females), pulmonary dysfunction including obesity hypoventilation syndrome, obstructive sleep apnea syndrome, cancer, and urinary incontinence. The obese elderly may also have to deal with functional limitations due to decreased muscle mass and strength and increased joint dysfunction, disabilities of (instrumental) activities of daily living, frailty, and an impaired quality of life.

Obesity is a major cause of frailty (OR 3.5 in 70–79-year-olds).

There are also beneficial effects of obesity, such as a higher bone mineral density and a lower risk of osteoporosis and hip fractures, with an extra cushioning effect of fat around the trochanter that may provide protection against hip fracture during a fall.

3.3 Treatment options in the elderly

A variety of treatment options are available. Whether they are indicated in combination or singly depends on a variety of factors, including risk, patient preferences, and available resources.

- Lifestyle interventions, involving diet, physical activity, and behavioral modification
- Pharmacotherapy
- Surgery

3.3.1 Lifestyle interventions

Lifestyle interventions should consist of a 500–1000 kcal deficit diet with a sufficient amount of high-quality protein (1.0 g/kg) and adequate supplementation of calcium (1000 mg/d) and vitamin D (10–20 µg/d), as well as multivitamin and mineral supplements, combined with exercise and behavioral therapy. Increased physical activity and regular exercise are not essential for achieving initial weight loss, but can help in maintaining weight loss and preventing weight from being regained.

Behavioral therapy includes self-monitoring, goal setting, social support, stimulus control, and relapse prevention.

Changes in the lifestyle of older persons present special challenges. An increased burden of disease, adverse quality of life, cognitive dysfunction and depression, isolation, loneliness, widowhood, dependency on others, and institutionalization may make it difficult to change the lifestyle.

Chronic disability and reduced physical and exercise capacity may interfere with the desired increase in physical activity. Obstacles such as impaired vision and hearing and limited financial resources are also faced by older adults.

The combination of a moderate energy-deficit diet, increased physical activity, and behavioral modification leads to a moderate weight loss of 0.4–0.9 kg/week or 8–10% in 6 months, with improvements in obesity-related medical complications and physical dysfunction, and is associated with a low risk of treatment-induced complications.

The efficacy of lifestyle interventions has to be assessed in studies including only elderly individuals or a large proportion of them. Systematic reviews of weight-loss interventions in people aged over 60 have shown significant changes, such as improved glucose tolerance and physical functioning, a reduced incidence of newly developed diabetes, and significant benefits for those with osteoarthritis, diabetes, and coronary heart disease.

One negative effect observed was a slight decrease in bone mineral density and lean body mass. Research has tended to focus too much on cardiovascular risks and not enough on the multiple effects of obesity on mobility, bladder function, sexual health, mood, and quality of life, which determine the quality of everyday life for elderly individuals.

3.3.2 Pharmacotherapy

Of the many drugs that have been developed to treat obesity, most have now been withdrawn from the market and only orlistat is currently approved for longer periods of administration in patients with a BMI ≥ 30 kg/m^2 and in patients with a BMI of 27–29.9 kg/m^2 in the presence of obesity-related comorbidity.

Orlistat, a lipase inhibitor, blocks the digestion and absorption of fat by up to one-third of the ingested amount, thereby causing an energy deficit of approximately 300 kcal/d. Weight loss with orlistat is 2–3 kg more than with a placebo and results in improved glucose tolerance and blood pressure, depending on the rate of weight loss.

In addition, orlistat has beneficial effects on dyslipidemia that are independent of weight loss. Gastrointestinal side effects include flatulence, fecal incontinence, oily spotting, urge, steatorrhea, and abdominal cramps. These occur if high-fat meals (> 20 g fat/meal) are consumed. Absorption of fat-soluble vitamins is reduced with orlistat, but values never fall into the deficiency range. When fat-soluble vitamins such as vitamin D are supplied, they should be ingested 2 hours before ingestion of orlistat. More liquid stools may be beneficial for many elderly people who suffer from constipation, but it may also result in fecal incontinence, with impaired internal and external sphincter function. An analysis of an older subpopulation in a 2-year randomized study in a primary care setting found that orlistat was just as effective in adults aged 65 or over as in younger adults. Gastrointestinal side effects also did not differ between older and younger patients.

3.3.3 Bariatric surgery

Bariatric surgery is indicated for individuals with severe obesity—i.e., with a BMI ≥ 40 kg/m^2 or a BMI ≥ 35 kg/m^2 with comorbidity. There are at present no guidelines for bariatric surgery in the elderly, but those who consider including the elderly have suggested that the values used in younger adults should be continued.

Recent research shows that older obese adults suffer from more comorbidity and require more medication before surgery than younger obese individuals. A significant loss of excess weight of 60% after 1 year and 50% after 5 years is observed after open or laparoscopic gastric bypass. This weight loss is associated with an improvement in obesity-related comorbidity and an overall reduction in medication requirements.

None of the published studies has provided any data on the number of patients in whom surgeons declined to perform the operation due to major life-limiting processes or unacceptable cardiorespiratory risk factors, or because the surgical risks outweighed the expected benefits. Most of the patients included in research studies have been women, and a very recent study in veterans has shown that sex difference is a factor that should be taken into account when assessing risk.

No survival benefit was observed during a mean follow-up period of 6.7 years in obese older men with obesity-related comorbidity. This might in part be explained by the shortness of the follow-up period, but it might also be related to the fact that bariatric surgery appears to be more difficult in severely obese male patients.

3.3.4 Nutrition aspects

Diet-induced weight loss results in a decrease in both fat mass and fat-free mass, with approximately 75% of the weight loss being composed of fat tissue and approximately 25% of fat-free mass. Weight loss in older persons may therefore exacerbate the age-related loss of muscle mass and further impair physical function. On the basis of intensive research on sarcopenia (age-related reduction in skeletal muscle mass in the elderly) and sarcopenic obesity, dietary guidelines have been adjusted to prevent sarcopenic obesity and to guide the medical profession in supporting weight loss in the presence of sarcopenic obesity.

Proteins and amino acids are constantly turned over in healthy muscle, with an equilibrium between protein synthesis and protein breakdown. Sarcopenia may be the result of increased rates of protein breakdown under the influence of cytokines produced in adipose tissue in a chronic state of low-grade inflammation. It may also be an effect of diminished protein synthesis, which is partly due to the anorexia of aging. Early satiety secondary to decreased relaxation of the fundus of the stomach, increased cholecystokinin release in response to fat intake, and increased leptin levels and declining testosterone levels in men may account for decreased food and nutrient intake.

Treating obesity requires creating an energy deficit, and in individuals with sarcopenic obesity, or who are at risk of developing it, the energy deficit to be established is more moderate than usual (500 kcal, with a range of 200–750 kcal), with the emphasis on a higher intake of proteins of high biological quality. When the energy intake is restricted, protein intake has to be maintained or increased, as dietary protein and amino acids are the most effective means of slowing or preventing muscle protein catabolism.

There is no evidence that co-ingestion of protein and fat affects protein anabolism. Aging in itself thus does not reduce the anabolic response to adequate quantities of high-quality protein; instead, it is the presence of carbohydrates that blunts this response, explained by the effects of insulin resistance on muscle protein synthesis. A carbohydrate intake of less than 150 g/day is therefore advised. A modest bout of physical activity such as 45 minutes of treadmill walking restores the ability of insulin to stimulate protein synthesis.

Protein intake should also be strategically timed in such a way as to overcome other consequences of aging, such as blunting of the anabolic response due to changes in digestion, gastric emptying rate, splanchnic uptake, and peripheral utilization.

In addition, in contrast to younger people, skeletal muscle in older individuals is not able to respond to low doses of protein and amino acids (7 g), but 10–15 g of amino acids are capable of stimulating protein synthesis to a similar extent as in the young.

Other potential strategies for enhancing protein synthesis are including leucine in the diet, from a minimum requirement of 2 g/day to an optimum of 6–8 g/day.

Leucine-rich foods include legumes (soy beans) and animal products (fish, beef). Leucine increases protein anabolism and decreases protein breakdown. Adding leucine to a mixed nutrient meal in older individuals resulted in a 56% increase in muscle protein synthesis.

3.3.5 Physical exercise programs

The American College of Sports Medicine recommends a multi-component training exercise program (strength, endurance, balance, and flexibility) to improve and maintain physical function in older adults.

Resistance training has been investigated as an approach to counteract sarcopenia in older adults by stimulating protein synthesis and causing muscle hypertrophy, with increased muscle mass and muscle strength and with improved physical functioning and performance of both simple and complex activities.

The fear that endurance and resistance training might interfere with each other negatively has not been substantiated in recent research, and a combination of progressive resistance training and aerobic exercise is the optimal exercise strategy for simultaneous improvement of insulin resistance and functional limitations in the elderly. Aerobic exercise is a second-best choice.

3.3.6 Barriers and perceived constraints on participation in physical exercise programs

The Screening and Counseling for Physical Activity and Mobility in Older People (SCAMOP) study included 619 patients aged 75–83, with BMI levels between 20 and 53 kg/m^2. The objective was to examine what the patients regarded as constraints on exercise and whether these perceived constraints explained the increased risk of physical inactivity. In comparison with the nonobese elderly (BMI 20–29.9 kg/m^2), the moderately obese (BMI 30–34.9 kg/m^2) had twice the risk of inactivity, and the severely obese (BMI $\geq$ 35 kg/m^2) had four times the risk of inactivity. Poor health, pain, diseases, and tiredness explained 27% of the increased risk of physical inactivity. Fears and negative experiences, such as fear of falling, fear of injury, exercise experienced as being uncomfortable, and insecurity when exercising outdoors, contributed 23% to the increased risk of inactivity. In the model, all of these factors, together with a general lack of interest in exercise, explained 42% of the increased risk of physical inactivity, leaving 58% unexplained. These factors were substantially more frequent among the severely obese. A meta-analysis of 43 studies in 33,090 60–70-year-olds rejected the hypothesis that interventions to increase physical activity do not affect activity among older adults.

Several modulating factors were found that can be used to increase physical activity in the elderly. Only physical activity should be targeted, and it should not be coupled with health education. The focus should also be on group activity, encouraging moderate exercise intensity and activity, incorporating self-monitoring, and encouraging center-based activities involving intense contact with the intervention staff at structured times.

4 Cascades

4.1 Stakeholders and management options

Which of the approaches to obesity treatment or prevention listed in Table 2 below is resource-dependent? All stakeholders need to take action at global, regional, and local levels. Excess weight and obesity, as well as the related chronic diseases, are largely preventable.

Individual level. The patient should avoid energy-dense foods, limit the intake of alcohol, remember the nonsatiating effects of foods rich in calories such as fat and alcohol (alcohol having an additional disinhibitory effect on eating), and bear in mind the better satiation and satiety effects of proteins followed by complex carbohydrates.

- Achieve energy balance and a healthy weight.
- Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats.

- Increase consumption of fruit and vegetables, as well as legumes and whole grains.
- Limit the intake of sugars (particularly in beverages).
- Increase physical activity.

Governments, international partners, civil society and nongovernmental organizations, and the private sector should:

- Shape healthy environments.
- Make healthier diet options affordable and easily accessible.
- Facilitate and promote physical exercise.

The food industry should:

- Reduce the fat and sugar content of processed foods and also the portion sizes.
- Increasingly introduce innovative, healthy, and nutritious choices (low energy density, fiber-rich, functional foods).
- Review current marketing practices to accelerate health gains throughout the world.

Table **2** Decision scheme for weight-loss treatment

			Obesity level		
			Grade 1	**Grade 2**	**Grade 3**
Western countries					
BMI	25.0–26.9	27.0–29.9	30.0–34.9	35.0–39.9	≥ 40
Waist (cm)					
Male	94–102	94–102	≥ 102	≥ 102	
Female	80–88	80–88	≥ 88	≥ 88	
Eastern/Asian countries*					
BMI	23.0–24.9	25.0–29.9	30.0–34.9	≥ 35	≥ 35
Waist (cm)					
Male	< 90	< 90	≥ 90	≥ 90	
Female	< 80	< 80	≥ 80	≥80	
Treatment options					
No comorbidity	Diet	Diet	Diet	Pharmacotherapy†	Surgery‡ if supervised diets with or without pharmacotherapy† fail
	Exercise	Exercise	Exercise	Supervised diets	
			Behavioral therapy	If these fail: surgery‡	
			Pharmacotherapy† ¶		
Comorbidity present	Diet	Diet	Diet	Pharmacotherapy†	Surgery‡ if supervised diets with or without
	Exercise	Exercise	Exercise	Supervised	

			Obesity level		
			Grade 1	**Grade 2**	**Grade 3**
	Behavioral therapy	Behavioral therapy	Behavioral therapy Pharmaco-therapy† §	diets Surgery‡ §	pharmaco-therapy† fail

BMI, body mass index; F, female; M, male. *Source:* Adapted from guidelines from the U.S. National Heart, Lung, and Blood Institute.

* Asians are at greater risk, and decisions are taken one step earlier in these patients.

† Only in patients with obesity-related disease who are unable to achieve adequate weight loss with available conventional lifestyle modifications and have no absolute contraindications for drug therapy.

‡ Only in patients with obesity-related disease who are unable to lose weight with available conventional therapy and have no absolute contraindications for surgery.

¶ While there is no evidence for surgery in patients with BMI 30–35 and no complications, exceptions are possible when there is significant comorbidity.

§ There is evidence for surgery in patients with BMI 35-40 and comorbidities; according to experts, the cut-off point is likely to be lowered to 30 during the next few years. But this may differ between different countries.

4.2 Management options relative to available resources

Table **3** Management cascade relative to available resources

	Management options by BMI			
Resources	**25–30**	**30–35**	**35–40**	**> 40**
High/affluent	DEB	DEB + M	DEB	DEB
			M + SD	SD + surgery
		± Surgery	± Surgery	± Surgery
Medium/normal	DEB	DEB	DEB	DEB
			SD	SD ± surgery
Low/absent	DEB	DEB	DEB	DEB ± surgery

DEB, diet, exercise, and behavior change (must be supervised); M, medication—only effective in case of moderate increase in BMI (must be supervised); SD, strictly supervised diets.

Notes:

1. Whatever treatment is given, diet, exercise, and behavioral changes should always be prescribed.

2. “± Surgery” is added to indicate that if the other strategies fail, then this is an option. Even in low-resourced countries, surgery is an option if obesity needs to be addressed. An open gastric bypass is not an expensive operation.

Table **4** Diet: cascade relative to the resources available

Resources	Diet types
	There should always be an energy restriction of at least 600 kcal below everyday needs, which is in practice even more restricted than the 600 kcal (since to maintain 1 kg in body weight, 20–25 kcal is needed, so that someone weighing 120 kg needs to eat at least 2400 kcal in order not to slim)
High/affluent	High-protein diets
	Low-carbohydrate diets
Medium/normal	High-fiber diets
	Low glycemic index diets
Low/absent	No energy-dense foods
	Reduced-fat diets

N.B.: The costs of the diet differ in countries in which fruits and vegetables are plentiful but meat is more expensive, and the reverse may be true elsewhere. It is of course difficult to emphasize energy restriction or reduction first, before discussing in detail the changes in macronutrients and diet composition.

Table **5** Surgery: cascade relative to the resources available

Resources available	Surgical procedure
High	Biliopancreatic diversion with duodenal switch
Normal	Laparoscopic gastric bypass
	Adjustable gastric band
	Sleeve gastrectomy
Low	Open gastric bypass; in severe obesity, a long-limb gastric bypass
	Vertical banded gastroplasty
	Sleeve gastrectomy
	Gastric band

5 Appendices and evidence

Click on one of the hyperlinks below for a more detailed discussion and evidence:

- Appendix I: Nutrition and diet
- Appendix 11: Pharmacotherapy
- Appendix III: Lifestyle changes
- Appendix IV: Surgery
- Appendix V: Obesity and the elderly

World Gastroenterology Organisation Global Guideline

Obesity

Appendix 1: Nutrition and diet

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Appendix 1: Nutrition and diet

Diets

A recent meta-analysis summarized current outcomes (Table I).

Table I Meta-analysis of diets in maintenance of weight loss: 29 studies with a follow-up period of at least 2 years

	Follow-up (y)	Studies (n)	Weight loss (kg)	WLM (kg)	WLM (%)	Weight reduction (%)
All	4.5	13	14.0	3.0	23.4	3.15
Men	4.4	5	18.3	4.7	30.5	4.48
Women	4.4	6	16.6	4.66	23.6	4.67
VLCD	4.5	4	24.1	7.05	29.4	6.59
HBD	4.5	8	8.8	1.99	17.8	2.11
Lower exercise	2.7	6	22.0	7.47	27.2	6.66
Higher exercise	2.7	6	20.9	14.99	53.8	12.49

HBD, hypoenergetic balanced diet; VLCD, very low-calorie diet; WLM, weight loss maintenance.

Source: Anderson et al., *American Journal of Clinical Nutrition* 2001;73:579–83.

The long-term efficacy of diets requires further study; currently available results are listed in Table II.

Table II Long-term efficacy of diets in 17 studies including 3030 patients, with a follow-up period of at least 3 years and an attrition rate of less than 50%—median follow-up 5 y (range 3–14 y) in 2131 patients (70%) and with maintenance of all weight loss or at least 9–11 kg of initial weight loss

		Range
Initial weight loss (median)	11 kg	4–28 kg
Successful weight maintenance	15%	0–49%
Influence of initial treatment		
Diet + group therapy	27%	14–31%
Diet alone	15%	6–28%
Diet + behavioral therapy	14%	0–49%
Influence of energy level of initial diet		
VLCD (300–600 kcal)	14%	6–49%
Conventional diet (800–1800 kcal)	18%	0–31%
Influence of intensity of follow–up		
Active approach	19%	13–49%

		Range
Passive approach	10%	0–31%
VLCD + behavioral therapy + active follow-up	38%	27–49%

VLCD, very low-calorie diet.

Source: Ayyard and Anderson, *Obesity Review* 2000;1:113–9.

The minimum energy required by a normal-weight adult who stays in bed is approximately 0.8 kcal/min (1150 kcal/day).

- This maintains body temperature, function of the heart and other organs, and tissue repair.
- High levels of physical activity can increase energy expenditure 4–8-fold.
- As a guideline, a normal adult needs approximately 22–25 kcal/kg nutrient intake to maintain 1 kg of body weight.

For weight loss to occur, energy intake must be less than energy expenditure.

- Predicted weight loss: 0.5–1.0 kg/week, based on a calorie deficit of 500–1000 kcal/day with no changes in physical activity.
- In general, diets < 800 kcal/day are not recommended.

Reduced-calorie diets include those specifying caloric intakes:

- Very low (less than 800 kcal/day)
  — To be used only when more rapid weight loss is needed
  — Medical monitoring is necessary
- Low (800–1500 kcal/day)
- Moderate (about 500 kcal less than typical daily intake)
- Lowering energy intake either by reducing the appetite or by lowering the energy density of the foods eaten is able to facilitate body weight reduction—more controlled intervention trials are needed to assess whether the effects on body weight are also sustained in the longer term.

Low-fat diets

Low-fat diets are still controversial, although epidemiologic and ecologic data have indicated an association between reduced fat intake and stabilizing or lower body weight.

- Low-fat diets: < 30% of total calories from fat
- Very-low-fat diet: restrict dietary fats to < 15% of total calories, 15% of calories from protein and 70% from carbohydrates; hard to maintain in the long term

Low-carbohydrate diets

These show better 6-month results than with low-fat diets, but the differences are no longer significant at 12 months.

- < 60 g of carbohydrates daily.
- Many diets (such as the Atkins and South Beach diets) start with < 20 g of carbohydrates daily and gradually increase the quantity.

High-fiber diets (legumes, vegetables, wholemeal diets)

Low-glycemic index (LGI) or low glycemic load diets

Lowering the glycemic load of the diet may be an effective method for achieving weight loss.

- LGI diets improve lipid profiles and can be easily incorporated into a person's lifestyle.
- Studies show that body mass, total fat mass, body mass index, total cholesterol, and LDL cholesterol can all decrease significantly with LGI treatment.
- A recent Cochrane systematic review concluded that overweight and obese people lost more weight on LGI diets than on high glycemic index or other weight-reduction diets and that their cardiovascular risk marker profile improved.
- More research is needed in order to determine the long-term effects and improvement in quality of life.

High-protein diets

In randomized trials, substituting protein for carbohydrates in calorie-restricted diets was found to result in more weight loss.

- Diets high in protein are usually high in fat.
- The rationale is that protein may enhance satiety, increase meal-induced thermogenesis, protect lean body mass, and decrease energy efficiency.

Specific commercial diets

In randomized trials, these diets appear to show similar losses of body fat and weight, similar reductions in blood pressure, and only modest differences in their effects on total cholesterol and fasting glucose levels.

- Mediterranean diet (fruit and vegetables, olive oil, nuts, red wine, very little red meat, fish)
- Atkins (carbohydrate restriction)
- Zone (40% carbohydrates, 30% fat, 30% protein)
- WeightWatchers or another, similar program (calorie restriction)
- Ornish (fat restriction to 10%)
- Rosemary Conley

Potential adjuncts to effective dietary management

- Using meal replacements—enhanced weight loss in randomized trials
- Involvement of dietitians—improved weight reduction in primary-care settings
- Eating breakfast
- Adding dietary fiber

World Gastroenterology Organisation Global Guideline

Obesity

Appendix 2: Pharmacotherapy

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Appendix 2: Pharmacotherapy

Introduction

Generally, drugs only play a role in settings in which resources are not a key issue. The medicines available for combating obesity are limited in number and effectiveness (Table III). Nevertheless, weight loss medications can help patients adhere to lifestyle advice, and may result in clinically significant and meaningful improvement of symptoms, risk factors, and quality of life. An understanding of the benefits and risks associated with each of the available drugs is required in order to allow appropriate selection and use of weight-management drugs.

The drug trials have generally only covered short periods, and no studies of long-term administration have been published. Most studies have reported treatment periods of 1–2 years. All medication is interrupted after 1–2 years, and as obesity is an incurable disease, it recurs in the same way as when insulin treatment for diabetes is stopped.

In randomized trials of medications approved by the United States Food and Drug Administration (FDA) combined with changes in lifestyle, in comparison with placebo and changes in lifestyle alone, it was found that the reduction from the initial weight was 3–5% greater with the medications.

- Reductions in risk factors for cardiovascular disease are generally related to the amount of weight reduction.
- The criteria for pharmacologic therapy in combination with lifestyle approaches to facilitate weight loss and prevent weight regain are:
  — BMI > 30
  — BMI > 27 plus coexisting conditions

Table **III** Drugs prescribed for weight loss

Drug Generic name, proprietary name (manufacturer)	**FDA approval**	**Schedule IV controlled substance**	**Mechanism**	**Dosage**	**Weight loss beyond that with placebo**	**Side effects**	**Comments**
Phentermine E.g.: Adipex-P (Gate); Fastin (Hi-Tech); Ionamin (Celltech)	Approved for weight loss	Yes	Sympatho-mimetic mechanism	15, 30, or 37.5 mg/d	4%	Dry mouth, insomnia, dizziness, mild increase in blood pressure (rarely more severe) and heart rate	Insufficient data from RCTs; increased risk of pulmonary hypertension probably not a concern; pregnancy category C; available as generic; requires blood-pressure monitoring
Diethylpropion Tenuate (Sanofi-	Approved for	Yes	Sympatho-mimetic	25 mg 3 × a day or	3%	Dry mouth, insomnia,	Has minimal effect;

Drug Generic name, proprietary name (manufacturer)	**FDA approval**	**Schedule IV controlled substance**	**Mechanism**	**Dosage**	**Weight loss beyond that with placebo**	**Side effects**	**Comments**
Aventis)	weight loss		mechanism	75 mg controlled-release daily		dizziness, mild increase in blood pressure and heart rate	excreted by kidneys; pregnancy category B; requires blood-pressure monitoring
Sibutramine Meridia (Abbott)	Approved for weight loss	No	Inhibition of norepinephrine and serotonin reuptake	5, 10, or 15 mg/day	5%	Mild increase in blood pressure and heart rate (rarely more severe), palpitations	Pregnancy category C; requires blood-pressure monitoring
Orlistat Xenical (Roche); Alli (GlaxoSmithKline)	Approved for weight loss	No	Lipase inhibition in gastrointestinal tract	120 mg 3 × a day (Xenical) or 60 mg 3 × a day; available over the counter (Alli)	3%	Oily spotting, flatus with discharge, fecal urgency	Side effects decrease with time; may work better when fat remains in diet, but this results in increased side effects; decreases LDL cholesterol; pregnancy category B
Rimonabant Acomplia (Sanofi-Aventis)	Not approved	n.a.	Inhibition of cannabinoid receptor CB1	20 mg/day	5%	Nausea, diarrhea, anxiety, depression	Prototype of a new class of prescription drugs. No longer available in Europe

FDA, Food and Drug Administration (United States); LDL, low-density lipoprotein; n.a., not available; RCT, randomized controlled trial. *Schedule IV controlled substance:* so listed under the Controlled Substances Act (1970) in the United States.

Phentermine and diethylpropion

- Randomized trials show a 3–4% greater weight reduction in comparison with placebo. (The drugs are no longer available in Europe.)
- Adrenergic stimulants enhance norepinephrine release in certain brain regions, leading to reduced food intake, but only limited data are available on efficacy and safety.
- Blood pressure should be closely monitored in patients who have prehypertension or are receiving treatment for hypertension.
- There is a potential (although low) risk of dependency and drug abuse (the agents are classified by the Drug Enforcement Agency in the United States as Schedule IV controlled substances).

- Approved for short-term use only; limited data suggest these stimulants may be effective for > 10 years.

Sibutramine

- Sibutramine is modestly effective in reducing weight, with differing effects on cardiovascular risk and various adverse effect profiles.
- Treatment with sibutramine reduced body weight but not blood pressure.
- Randomized trials have shown a 5% greater weight reduction in comparison with placebo (but only short-term trials have been carried out; administration of the drug for more than 18 months is not allowed).
- The drug is a serotonin–norepinephrine reuptake inhibitor that reduces appetite. Combination with lifestyle modification resulted in more weight loss at 12 months (combination: 12.1 kg; sibutramine alone 5.0 kg; lifestyle intervention alone 6.7 kg).
- Patients who had the greatest initial weight loss and were most physically active were most likely to maintain weight loss successfully.
- Common side effects: hypertension and tachycardia (related to adrenergic properties).

Orlistat

- Orlistat is modestly effective in reducing weight, with differing effects on cardiovascular risk and various adverse effect profiles.
- In patients with essential hypertension, therapy with a weight loss diet or orlistat treatment reduced body weight and blood pressure.
- One study of orlistat plus lifestyle changes reported a weight reduction of approximately 3% more than with lifestyle intervention alone.
- The drug is a triacylglycerol lipase inhibitor and causes a 30% reduction in dietary fat absorption in the intestinal lumen.
- It is available over the counter at lower dosages in the United States (60 mg, three times a day).
- It has been shown to result in about 2% more weight loss in comparison with placebo over a period of 4–24 months.
- The pharmacologic effect depends on the presence of dietary fat, but a low-fat diet is recommended for patients receiving orlistat.
- Major side effects (usually short-lived) include oily spotting, flatus with discharge, and fecal urgency.

Rimonabant

- Rimonabant administration produces modest weight loss of approximately 5% after 1 year.
- The drug is a selective cannabinoid receptor CB1 blocker. The cannabinoid system contributes to the regulation of food intake, energy balance, and body weight.
- Modest amounts of weight loss may still be potentially beneficial.
- It is a new medication; better-quality studies with longer follow-up periods after treatment are needed before definitive recommendations can be made.

- It has been approved for the treatment of obesity in most of Europe and in Mexico and Argentina.
- It has not approved by the FDA due to concerns about side effects (including depression, anxiety, nausea and diarrhea, suicidal ideation, and suicide).
- In Europe, it is contraindicated in patients with severe depression and/or patients receiving treatment with antidepressive medications.
- It is not recommended for patients with other untreated psychiatric conditions.
- It is only allowed to be taken for a maximum of 2 years.

Other drugs

- Fluoxetine (for obese patients with sleep apnea, night-time binges, and bulimia)
- Topiramate (for obese patients with bipolar disorder)
- Bupropion (for obese patients who are smokers)
- Metformin (for obese patients with diabetes, obese women with polycystic ovaries, and obese individuals receiving antipsychotic drugs that produce insulin resistance)
- Venlafaxine (for binge eating)

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Obesity

Appendix 3: Lifestyle changes

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Appendix 3: Lifestyle changes

Physical activity

- Exercise is recommended as a weight loss intervention, particularly when combined with dietary change.
- The combination of increases in physical activity and caloric restriction results in more weight reduction and body composition changes (fat versus lean mass) than diet or physical activity alone.
- Exercise is associated with improved cardiovascular disease risk factors even if no weight is lost:
  — It reduces abdominal adipose tissue and improves insulin resistance.
  — It increases plasma high-density lipoprotein (HDL) cholesterol levels and reduces triglyceride levels and blood pressure.
  — Resistance training may be particularly beneficial in modifying body composition.
  — Adults should set a long-term goal of a minimum of 30 min of moderate-intensity physical activity per day.
  — Exercise is a predictor of weight maintenance.

Behavioral modification and counseling

Behavioral therapy (Table IV) may result in an 8–10% loss in body weight at 6 months.

Table **IV** Behavioral therapy: studies published 1990–2000

Duration of behavioral therapy (months)	Studies (n)	Average weight loss (kg)
5	12	10.4 (11.1%)
18	7	8.2 (9.5%)
24	2	7.1 (7.0%)
12	USPSTF RCTs	3.7–5.7

RCT, randomized controlled trial; USPSTF, United States Preventive Services Task Force.

Sources: Wing RR, “Behavioral approaches to the treatment of obesity,” in: Bray GA, Bouchard C, James WPT, editors, *Handbook of obesity,* 2nd ed. (New York: Dekker, 1998), pp. 855–74; McTigue et al., *Annals of Internal Medicine* 2003;139:933–49; Kushner, *Surgery for Obesity and Related Diseases* 2005;1:120–2.

- Psychological interventions, particularly behavioral and cognitive-behavioral strategies, enhance weight reduction.
- Mainly useful when combined with dietary and exercise strategies.
- Long-term maintenance programs may facilitate lasting behavioral changes that work against weight regain.
- Psychotherapy-related approaches—e.g., relaxation therapy or hypnotherapy—failed to demonstrate decisive positive outcomes.

Behavioral treatment is generally provided in individual or small-group sessions held weekly for 6 months. Its key features include:

- Goal-setting and dietary advice
- Self-monitoring—with a self-recorded food diary
- Stimulus control
- Cognitive restructuring—perception of emotional eating behavior and eating habits
- Relapse prevention

Maintenance of weight reduction

The body has multiple mechanisms for modifying the energy balance to reestablish the original body weight. Weight loss induces a reduction in energy expenditure, hindering maintenance of weight loss. Failure to maintain weight loss is a common problem.

While short-term weight loss depends on caloric restriction, maintenance of weight loss mostly depends on the level of physical activity. For most people, long-term success is still difficult to achieve and current therapies for obesity do not provide sufficient support for patients in adhering to the required lifestyle changes.

Predictive factors for maintaining weight loss include:

- Eating a low-fat, fiber-enriched, protein-rich diet
- Frequent self-monitoring of body weight and food intake
- High levels of physical activity
- Long-term patient–provider contact
- Weight loss of more than 2 kg in 4 weeks
- Frequent/regular attendance at a weight loss program
- Patient's belief that body weight can be controlled
- Behavioral interventions (may be helpful)

Protective factors against weight regain: expending about 2500 kcal/week, either through:

- Moderate activity for approximately 80 min/day (brisk walking)
- Or vigorous activity for 35 min/day (jogging)

Treatment and support options:

- Primary-care setting
- Commercial programs
- Internet-based weight maintenance programs

World Gastroenterology Organisation Global Guideline

Obesity

Appendix 4: Surgery

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Appendix 4: Surgery

Introduction and key points

It is difficult to compare different treatment options with surgery, as there have been few trials. Most results reported for diets and medications are short-term results. Although there are some data for medication that show results up to 2 years, a proper comparison of different options would need to include 5-year or even 10-year results when available or state that there are no long-term results. Studies of surgical treatment do report long-term results, with follow-up periods of 1, 3, 5, and even 10 years in some instances. Larger numbers of randomized studies using intention-to-treat analysis are needed.

The type of surgical intervention used depends on body mass index (BMI) and available resources. Adjustable gastric bands are the least invasive, safest, and most effective intervention and this is therefore probably the preferred surgical approach. When finances do not permit this approach, a gastric bypass is the next best operation. For patients with a BMI > 60, gastric bypass is the best surgical procedure, although there have been some reports that gastric bands are also effective. However, the choice of surgery should always take account of individual circumstances and can never be based on BMI alone.

Bariatric surgical procedures

Bariatric surgical procedures reduce caloric intake by modifying the anatomy of the gastrointestinal tract. In the United States, the Roux-en-Y gastric bypass (open or laparoscopic) is the most commonly used operation. Bariatric operations can be classified into three types: restrictive procedures, malabsorptive procedures, and combined restriction–malabsorption procedures.

Restrictive procedures limit intake by creating a small gastric reservoir with a narrow outlet to delay emptying. These include:

- Gastric stapling (gastroplasty)—a recently developed method involving vertical restrictive (sleeve) gastrectomy (Fig. **1b**). Partial gastric resection leaves a narrow tube of stomach as an alimentary conduit.
- Adjustable gastric banding (Fig. **1a**). This operation is performed laparoscopically and has been in use since 1995. It includes insertion of a subcutaneous reservoir. The extent of gastric restriction can be adjusted using injections of saline into the reservoir.

Malabsorptive procedures bypass varying portions of the small intestine, where nutrient absorption occurs.

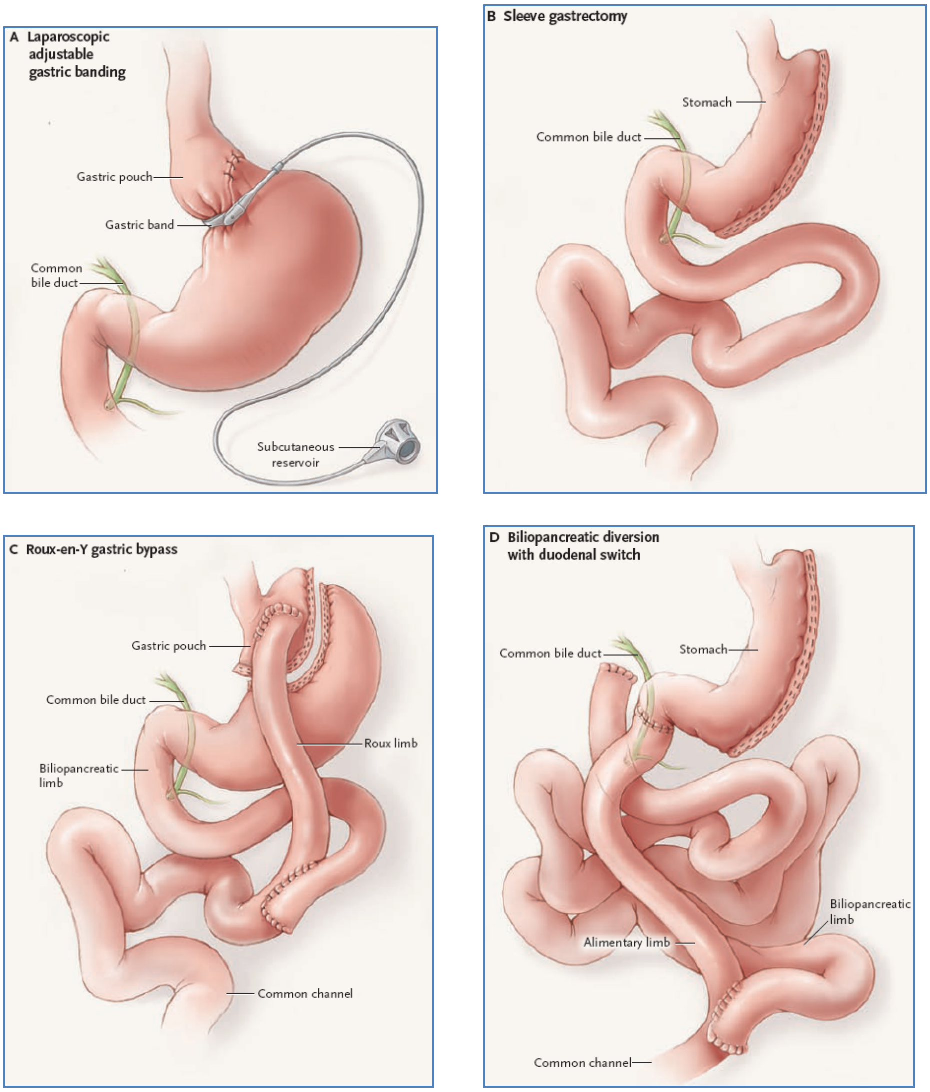
Combination restriction–malabsorption procedures:

- Proximal Roux-en-Y gastric bypass (Fig. **1c**). This is the procedure most commonly used in the United States.
  — Food only comes into contact with pancreatic and biliary secretions below an anastomosis.
  — The shorter the alimentary part of the small-intestine segment, the less absorption will occur and the better the results will be.

- Biliopancreatic diversion (Fig. **1d**)
  — Causes less gastric restriction than the Roux-en-Y procedure.
  — The duodenal switch procedure usually includes sleeve (vertical) gastrectomy.

Combination procedures are sometimes performed as staged operations, with restriction followed by a Roux-en-Y procedure after initial weight loss has made surgery less difficult and reduced the operative risk.

Fig. **1** Classification of bariatric surgery



Contraindications, associated risks, and complications

Contraindications:

- Mental or cognitive impairment (precluding informed consent)
- Severe coexisting medical conditions
- Unstable coronary artery disease
- Advanced liver disease with portal hypertension

Mortality risks associated with bariatric surgery:

- 30-day mortality rate 0.05–2.0%

- Common causes of death:
  — Pulmonary embolism
  — Anastomotic leaks
- Factors that contribute to increased mortality:
  — Lack of experience of the surgeon or hospital
  — Patient's age
  — Male sex
  — Severe obesity—BMI ≥ 50
  — Coexisting conditions

Perioperative complications:

- 13% of patients in the Swedish Obese Subjects (SOS) trials had perioperative complications.
- Pulmonary thromboembolism is the major cause of operative mortality; anticoagulant prophylaxis is imperative.
- Anastomotic leaks.
- Wound infections.
- Bleeding.
- Incidental splenectomy.
- Incisional and internal hernias.
- Early small-bowel obstruction.

Postoperative gastrointestinal complications:

- Nausea and vomiting occur in > 50% of patients undergoing restrictive procedures:
  — Due to eating too much or too rapidly
  — Due to anastomotic strictures
- Dumping syndrome occurs in 70% of patients after Roux-en-Y gastric bypass. There is a complex of neurohormonally mediated symptoms:
  — Facial flushing
  — Light-headedness
  — Palpitations
  — Fatigue
  — Diarrhea
- Nutrient deficiencies may occur after procedures with a component of malabsorption. These require regular monitoring and replacement:
  — Iron
  — Calcium
  — Folate
  — Vitamin B_{12}
  — Protein malnutrition
  — Fat-soluble vitamins A, D, E, and K
- Other complications include:
  — Dehydration
  — Bowel obstruction
  — Anastomotic leaks
  — Strictures and adhesions
  — Erosions and ulcers

— Internal and incisional hernias
— Cholelithiasis

Psychosocial factors have also been associated with a suboptimal surgical outcome:

- Disturbed eating habits (e.g., binge eating)
- Substance abuse
- Low socioeconomic status
- Limited social support
- Unrealistic expectations of surgery
- Psychiatric disorders: a majority of patients presenting for bariatric procedures have one or more psychiatric disorders.

Patients often require readmission or reoperation for complications or treatment of coexisting conditions. The risks require a multidisciplinary assessment including the following fields:

- Medical
- Surgical
- Nutritional
- Psychological

Results

Patient outcome:

- The potential benefit of bariatric surgery for patients with mild obesity (BMI 30–35) remains unclear. One randomized study reported significant benefits of surgery using an adjustable gastric band in comparison with medical therapy and behavior modification.
- The safety and efficacy of laparoscopic adjustable gastric banding (LAGB) have been demonstrated as a surgical therapy for morbid obesity in the short term. Recent research on LAGB with the Swedish Adjustable Gastric Band (SAGB) shows that it is effective in achieving a mean sustainable weight loss of > 50% at 8 years after surgery, with an acceptably low morbidity rate.
- It is uncertain whether patients with extremely severe obesity are appropriate candidates for bariatric surgery.
  — The operative risk may be greater for these patients, and surgical access may be difficult to impossible. Mortality rates may be higher among patients with a BMI ≥ 70.
  — In the obese, bariatric surgery may be risky, but the risk of not reducing their weight may well be greater than the risks of the operation. This will continue to be an area of uncertainty until the results of further trials become available.
- The effectiveness of procedures varies and there are limited long-term outcome data:
  — No large, randomized trials have compared current bariatric surgical techniques with medical management of severe obesity.
  — A 2005 Cochrane Review suggests a typical weight loss of 20–50 kg (44–110 lb) with various bariatric procedures, in comparison with a modest weight gain in medically treated patients.
  — The Swedish Obese Subjects (SOS) trial showed weight changes that were significantly greater in the surgical group than in the control group. However, the gain in life expectancy observed in the SOS study was modest.

— In general, weight loss with malabsorptive procedures tends to be greater than weight loss with solely restrictive procedures.
— Improvement in obesity-associated conditions—including diabetes, hyperlipidemia, hypertension, and sleep apnea—is reported after bariatric surgery.
— The SOS data suggest that some of these benefits, although still significant, are less marked at 10 years than at 2 years.

Other treatment options

Intragastric balloon

- A soft, saline-filled balloon is placed in the stomach endoscopically. It promotes a feeling of satiety and restriction.
- Obesity treatment with an intragastric balloon (IGB) itself, and the technique of positioning the balloon, appear to be safe.
- Placement is temporary (6 months) and the method can be used prior to surgery in patients with morbid obesity.
- There appears to be little additional benefit of the intragastric balloon in relation to weight loss.
- IGB placement is reported to enhance motivation and encourage patients to change eating habits, following a well-organized diet and a program of behavioral modification. IGB may serve as an adjuvant factor in achieving and maintaining weight loss.
- Balloon treatment is permitted for a maximum period of 6 months; removal of the balloon leads to recurrence of the disease.

Liposuction

- Liposuction involves the removal of fat by aspiration after an injection of physiologic saline.
- The treatment can result in a significant reduction in fat mass and weight. However, recent research has shown that abdominal liposuction does not significantly improve obesity-associated metabolic abnormalities and that reducing adipose tissue mass alone does not achieve the metabolic benefits of weight loss.
- No clear positive influence on insulin sensitivity or risk factors for coronary heart disease has been reported.

Obesity and the Elderly

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Introduction

In most countries there has been a rapid and continuing increase in life expectancy. By the year 2030, 20% of the adult US population will be older than 65 years and in Europe roughly 2 active people (aged 15-65) will be caring for one inactive older person (Han et al. 2011). This increase in life expectancy has not necessarily meant in increase in healthy life years but in extra years of illness proneness. This, together with the epidemic of obesity, which shows and upward shift into older ages, signifies a double disease burden in the near future. Obesity in the elderly (here defined as age ≥ 65 years unless otherwise stated) is obviously a matter of concern (Rössner 2001).

Prevalence of obesity in the elderly

The prevalence of obesity is rising progressively, even among older age groups. Based on NHES I and NHANES I-III, Arterburn et al. estimated that the prevalence of obesity (BMI ≥ 30 kg/m^2) in elderly Americans, aged 60 years and older, would increase from 23.6% in 1990 and 32.0% in 2000 to 37.4% in 2010 (ranging from 33.6% in the best-case estimate – based on the lowest increase in prevalence of 0.1% – to 39.6% in the worst-case estimate – based on the continuation of the dramatic increase in prevalence of 7% –)(Arterburn et al. 2004). This signifies an increase in the number of obese older adults from 9.9 (1990) and 14.6 (2000) to 20.9 million in 2010 (range 18.0-22.2 million). Whether these projections are borne out is still unknown at present.

The Behavioural Risk Factor Surveillance System (BRFSS) survey provided data on 52 921 subjects aged 65 years and older (Li et al. 2005). In the age group 65-74 years, 25% had a BMI of ≥ 30 kg/m^2 which was significantly more than the 16.6% prevalence in the 75-84 year age group and the 9.9% prevalence in the ≥ 85 year age group.

Also the obesity prevalence in nursing homes is an escalating problem (Bradway et al. 2008). A multi-state study of newly admitted nursing home residents found an alarming 30% of adults aged 65 and older to have a BMI of 35 or greater (Lapane & Resnik 2005). Almost 30% of US nursing homes reported that 15-20% of the residents within the nursing homes were obese. Evidence suggests that obesity and weight gain increase the relative risk of nursing home admission for community-dwelling older adults. For those aged 65-74 the risk of admission increased by 31% (Valiyeva et al. 2006). Those who were overweight and experienced a significant weight gain were 2.13 times as likely to be admitted to a nursing home (Zizza et al. 2003).

In Europe, the prevalence of obesity increases with age to a peak of about 60 years. Thereafter, body weights change little and begin to decline in older age. However, current secular trends indicate that the prevalence of obesity will increase. The Scottish Health Survey, for example, has recently shown that in the 10 years between 1998 and 2008, while the overall prevalence of obesity showed little increase, the BMI increase continued to rise between age 60 and 70, especially in women(Han et al. 2011). In that same period, waist circumference showed a 5-10 cm secular increase in both sexes at ages between 50 and 70 years. This disproportionate increase in waist circumference with a smaller increase in BMI in the Scottish Health Survey may indicate an unfortunate circumstance of gain in visceral fat mass and loss of lean tissue which are both major determining factors of ill health in the obese elderly (Han et al. 2011).

Pathophysiology of obesity in the elderly

Ageing is associated with marked changes in body composition and metabolism (Villareal et al. 2005, Zamboni et al. 2005, Kennedy et al. 2004). From age 20-30 there is a progressive decrease of fat free mass (mainly muscle) of 40% between age 20 and 70 with a relatively greater decrease in peripheral fat free mass than in central fat free mass, while fat mass rises with age. After age 70, fat free mass and fat mass decrease in parallel. Redistribution of fat with an increase in visceral fat occurs with ageing and is more marked in women than in men. Also, fat is increasingly deposited in skeletal muscle and in the liver. The redistribution of fat is the main determinant of impaired glucose tolerance in the elderly and more important than obesity itself. Increased intramuscular and intrahepatic fat contribute to impaired insulin action through locally released free fatty acids.

Due to the loss of skeletal muscle, the basal metabolic rate declines with 2-3% per decade after age 20, with 4% per decade after age 50, corresponding to approximately 150 kcal/d per decade, and overall with 30% between age 20 and 70 (Chau et al. 2008). This, together with a decreased intensity and duration of physical activity and decreased postprandial energy expenditure due to a decreased fat oxidation, explains the decreased energy expenditure with ageing.

Both obesity and ageing are characterised by a low-grade inflammatory state and by endocrine changes. Central and visceral obesity is more proinflammatory than global obesity (Schrager et al. 2007). The low-grade inflammatory state is associated with decreased lean body mass, reduced immune function, cognitive decline and insulin resistance and several correlates of metabolic control and insulin resistance such as increased levels of TNF-α, IL-6, CRP, α1-antichymotrypsin and ICAM-1 (intercellular adhesion molecule-1). TNF-α and IL-6 have catabolic effects on muscle mass and are involved in sarcopenia, a steady and involuntary loss of skeletal muscle mass with ageing resulting in decreased physical

performance, mobility disability, and frailty (Kennedy et al. 2004, Florez & Troen 2008, Waters et al. 2010, Zamboni et al. 2008).
Endocrine changes related to obesity in the elderly include decreased oestrogen levels (females), decreased total testosterone (females and males) and free testosterone (males) levels, decreased sex hormone binding globulin (SHBG) and dihydroxyepiandrosterone (DHEA) levels, decreased growth hormone and insulin-like growth factor-1(IGF-1) production, increased prolactin and cortisol levels, changes in thyroid hormones (increased free T4 and reversed T3 and decreased T3 levels) and secondary hyperparathyroidism in the presence of low vitamin D levels (Kennedy et al. 2004; Kennedy et al. 2008). Leptin and insulin resistance, increased resistin levels, increased free fatty acid levels and downregulation of ghrelin are also present. The changes in gonadal axis and in other hormones that occur with normal ageing, seem to be exaggerated in the presence of abdominal obesity and insulin resistance (Kennedy et al. 2004).

Health consequences of obesity in the elderly

It is far from clear which parameter would predict best the poor health and poor outcome of obesity in the elderly. The BMI values, which correlate with body fat in the young and middle-aged, underestimate the degree of fatness because of changes in body composition, and overestimate the degree of fatness because of loss of height in the presence of vertebral compression and kyphosis. Moreover, the effect of ageing on body fat distribution with increased omental and mesenteric fat and intramuscular and intrahepatic fat deposition, all risk factors for insulin resistance, and the fact that the size of the fat mass at any given value of BMI is greater in the elderly than in younger adults, detracts the potential of BMI from being used to estimate disease and medical risks. The waist circumference which correlates highly with total fat and intra-abdominal fat, might be a better parameter to predict adverse health effects of obesity in the elderly (Han et al. 2011). However, the waist circumference measures best apt to being used as cut-off values for the elderly are unknown.

The NHI/NHLBI guidelines, published in 1998, suggested that a 70-year old person with a weight of 84 kg and a height of 1.6 m (BMI 25 kg/m^2) and one of the mentioned risk factors would be a candidate for weight reduction treatment and intervention (NHI 1998). This was questioned by Heiat et al. in 2001 and by Janssen and Mark in 2007 (Heiat et al. 2001, Janssen & Mark 2007). Heiat et al. reviewed 13 articles that reported the association between BMI and all-cause and cardiovascular mortality in non-hospitalised subjects older than 65 years with a follow-up of more than 3 years (Heiat et al. 2001). They did not find support for overweight conferring an excess mortality risk and found a small relative mortality risk in higher BMI ranges (BMI 28-29 kg/m^2 RR 1.15-1.34; BMI 30-35 kg/m^2 RR 1.31-2.0). The relation between BMI and all-cause mortality was described as a U-shaped curve with a large flat bottom and a right curve that started to rise for a BMI > 31-32 kg/m^2. Janssen and Mark performed a meta-analysis of 28 articles on the association of BMI and all-cause mortality in subjects 65 years and older with a follow-up of at least 1 year (Janssen & Mark 2007). They found that a BMI in the overweight range was not associated with an increased risk (risk estimate 1.0 (0.97/1.03)) and that a BMI in the moderately obese range with a modest increased risk (risk estimate 1.10 (1.06/1.13)), which was marginally higher for women (risk estimate 1.18 (1.13/1.24) versus 1.10 (1.02/1.18) in males)).

A slightly higher BMI value associated with a lower relative mortality in the older compared with the younger adults has not to be misinterpreted that obesity is not as harmful in the elderly. BMI may be a less appropriate index in the elderly (Han et al. 2011). One should also realize that although the relative risk of mortality and decreased survival seem to decrease at ages above 59, the absolute mortality risk increases with increasing BMI till age 75 (Villareal et al. 2005). Also, many confounding factors contribute to an underestimation of the health risks of obesity in the elderly (Zamboni et al. 2005). Among them are the survival effect (the presence of “resistant” survivors in whom the relation between BMI and mortality is lost), competing mortalities, relatively shortened life expectancy in the old age and the importance of age of onset and duration of obesity, as those who became obese in old age may die before the adverse effects of obesity become apparent. Also, smoking, weight change (weight gain and weight loss may be more detrimental than stable weight) and unintentional weight loss may confound the estimation of health risks. The underlying disease (reverse causation), physical activity and cardiorespiratory fitness (a lean unfit may have a higher mortality than an obese fit subject and the obese unfit a higher mortality than the lean fit), fat distribution (unknown in many studies) and length of follow-up (as with shorter duration no association between obesity and mortality is evident) also play a role (Zamboni et al. 2005). The inverse relation between BMI and mortality (the obesity paradox) in a recent study in male veterans aged 40-70 years at entry could be explained by some of the above mentioned factors: reverse causation, veteran effect (becoming obese after discharge from the service), survival effect and being a healthy obese. Both a high fitness state and a high BMI reduced mortality independently in the US Veterans study (McAuley et al. 2010, Ades & Savage 2010).

Medical complications of obesity in the elderly are mainly concentrated around the metabolic syndrome (with glucose intolerance, hypertension, dyslipidemia and cardiovascular disease). The metabolic syndrome peaks at age 50-70 in males and age 60-80 in females with an odds ratio of 5.8 in 65-year old males and 4.9 in 65-year old females compared to 20-34 year old subjects (Goodpaster et al. 2005). Other obesity-related disorders are (osteo)arthritis (with an OR of 4.8 for males and 4.0 for females), pulmonary dysfunction including the obesity hypoventilation syndrome and obstructive sleep apnoea syndrome, cancer and urinary incontinence (Villareal et al. 2005, McTigue et al. 2006, Han et al. 2011).

The obese elderly may also have to deal with functional limitations because of decreased muscle mass and strength and increased joint dysfunction, disabilities of (instrumental) activities of daily living, frailty and impaired quality of life (McTigue et al. 2006, Villareal et al. 2005, Han et al. 2011). Obesity is an important cause of frailty (OR 3.5 in 70-79 year olds). There are also beneficial effects of obesity such as a higher bone mineral density and a lower risk of osteoporosis and hip fractures with an extra cushioning effect of fat around the trochanter that might provide protection against hip fracture during a fall. Hormonal factors such as insulin, leptin and oestrogens are involved by stimulating bone growth and inhibiting bone remodelling.

Who should lose weight and what are the concerns?

The above mentioned considerations resulted in a revised recommendation of weight loss only for **obese** older subjects with weight-related co-morbidities or functional limitations by the American Society of Nutrition and the North American Association for the Study of Obesity in 2005 (Villareal et al. 2005, Villareal et al. 2005).

Adverse effects of intentional weight loss should be taken into account such as the loss of bone mineral density loss and loss of fat free tissue. At least in the non-overweight elderly, weight loss and a decrease in fat mass may be associated with an increased risk of hip fractures (Ensrud et al. 1997, Schott et al. 1998). In young adults 75% of diet-induced weight loss is composed of fat tissue and 25% is composed of fat free tissue. The relative amount of diet-induced weight loss as fat free mass and fat mass in older men and women is similar to that observed in younger adults (Dengel et al. 1994, Gallagher et al. 2000). Therefore, diet-induced weight loss does not produce a proportionally greater loss of lean tissue in older patients.

This moderate loss of lean body mass is not relevant in obese subjects who not only have more fat mass but also more muscle mass to support the body and to enable movements and physical exercise with a more heavier body weight. This might not be the case in a specific condition, named sarcopenic obesity. In 2004, Roubenoff used the word sarcopenic obesity to characterize the confluence of two epidemics (Roubenoff 2004). Sarcopenic obesity is a unique weight status in the elderly: a combination of an unhealthy excess of body fat with a detrimental loss of muscle and fat free mass including bone (Zamboni et al. 2008, Miller & Wolf 2008). In sarcopenic obesity the proportion of muscle mass is low relative to the total weight. There is a loss of muscle quantity and quality with a decreased number and size of muscle fibres, with a reduced mitochondrial function and a decreased synthesis of muscle protein. These changes result in a decreased functional capacity and quality of life, increased risk of disability, morbidity and mortality, and increased risk of frailty, falls and loss of independency. The pro-inflammatory cytokines TNF- and IL-6 produced in adipose tissue stimulate the degradation of protein and induce muscle wasting, whereas both sarcopenia and obesity are associated with a decrease in anabolic hormones such as testosterone and IGF-1 (Zamboni et al. 2008, Kennedy et al. 2004, Kennedy et al. 2008, Miller & Wolf 2008).

Baumgartner et al. demonstrated that obesity and sarcopenia were each strongly associated with disability (OR of obesity 1.34 in males and 2.15 in females; OR of sarcopenia 3.78 in males and 2.96 in females)(Baumgartner et al. 2004). Both combined were more strongly associated than either alone (OR 8.72 in males and OR 11.98 in females). The hazard ratio of a drop in 2 instrumental activities of daily living (IADL) over a 7-year follow-up period in the presence of sarcopenic obesity was 2.5-3.0 and this drop of 2 IADLs was associated with a more than 5 times higher mortality (28.6% versus 5.6%) in the short term (1.5 versus 2.3 years). These measures of physical capacity were self-reported. Bouchard et al. measured objectively the physical capacity in almost 900 subjects of 68-82 years old (Bouchard et al. 2009). Obesity per se appeared to contribute more to a lower physical capacity than sarcopenia with the lowest values of physical capacity in non-sarcopenic and sarcopenic obese subjects and with a twice as high value in non-sarcopenic and sarcopenic non-obese subjects.

So, the question of whom to treat was refined to patients who are **obese** and who have functional limitations or metabolic complications that can benefit from weight loss by a weight loss therapy that minimizes muscle and bone loss. The focus of treatment should be a reduction of intra-abdominal fat with preservation of muscle mass and muscle strength (Kennedy et al. 2004).

Treatment options in the elderly

The current therapeutic tools available for weight management in the elderly are (Villareal et al. 2005):

1. lifestyle intervention involving diet, physical activity and behavioural modification;
2. pharmacotherapy;
3. surgery.

Lifestyle intervention

Lifestyle intervention should consist of a 500-1000 kcal deficit diet with a sufficient amount of high quality protein (1.0 g/kg) and adequate supplementation of calcium (1000 mg/d) and vitamin D (10-20 mcg/d) and multivitamin and mineral supplements, combined with exercise and behavioural therapy. Increased physical activity and regular exercise are not essential for achieving initial weight loss but it can help to maintain the weight loss and prevent weight regain. Elements of aerobic exercise, resistance training, balance and flexibility training may be of particular benefit in older persons because it improves physical function and can ameliorate frailty. Behavioural therapy includes self-monitoring, goal setting, social support, stimulus control and relapse prevention.

Changes in the lifestyle of older persons present special challenges. An increased burden of disease, adverse quality of life, cognitive dysfunction and depression, isolation, loneliness, widowhood, dependency from others and institutionalisation may make it difficult to change the lifestyle (Villareal et al. 2005). Chronic disability, reduced physical and exercise capacity may interfere with the desired increase in physical activity. Also, obstacles such as impaired vision and hearing and limited financial resources are faced by older adults.
The combination of a moderate energy-deficit diet, increased physical activity and behavioural modification causes a moderate weight loss of 0.4-0.9 kg/week or 8-10% in 6 months, induces improvement in obesity related medical complications and physical dysfunction and is associated with a low risk of treatment induced complications (Villareal et al. 2005).

The efficacy of life-style interventions has to come from studies that include only or a large number of elderly subjects. In the Diabetes Prevention Programme, obese men and women up to the age of 84 years were included to follow a programme of moderate physical activity of at least 2.5 hours a week, a reduction in total dietary fat to less than 25% of total energy, coupled with sessions with a life-style counsellor (Diabetes Prevention Program Research Group 2006). Every kilogram of weight loss through diet and exercise reduced the incidence of diabetes type 2 with 16% over a period of 3.2 years and with 3.3 cases per 100-patient years in the 60-85 year age group, half of that obtained in the younger age group of 25-44 years of age.

Two systematic reviews of weight loss interventions in people aged over 60 years revealed significant changes such as improved glucose tolerance and physical functioning, a reduced incidence of newly developed diabetes and significant benefits for those with osteoarthritis, diabetes and coronary heart disease (McTigue et al. 2006, Bales & Buhr 2008). A negative effect concerned a slightly decreased bone mineral density and lean body mass. Research has tended to focus excessively on cardiovascular risks but insufficiently on the multiple effects of obesity on mobility, bladder function, sexual health, mood and quality of life which determine the everyday life of the elderly (Han et al. 2011).

Pharmacotherapy

In most randomised clinical trials older subjects are excluded. The average age of subjects ranged from 34 to 54 in a meta-analysis of pharmacotherapy (Li et al. 2005). Of the many drugs that were developed to treat obesity most were withdrawn from the market and only orlistat is currently approved for a longer period in patients with a BMI ≥ 30 kg/m^2 and in

patients with a BMI of 27-29.9 kg/m^2 in the presence of obesity-related co-morbidity (Bray & Tartaglia, Bray & Ryan 2007, Bray 2009).
Orlistat, a lipase inhibitor, blocks the digestion and absorption of fat up to one-third of the ingested amount, thereby causing an energy deficit of approximately 300 kcal/d. The weight loss by orlistat is 2-3 kg more than with placebo. and results in improvement in glucose tolerance and blood pressure dependent of the rate of weight loss (Li et al. 2005, Padwal & Majumdar 2007, Rucker et al. 2007). Moreover, orlistat has a weight loss independent beneficial effect on dyslipidemia (Hollander et al. 1998, Muls et al. 2001).

Gastrointestinal side effects are a result of its action and consist of flatulence, faecal incontinence, oily spotting, urge, steatorrhoea and abdominal cramps. They occur if high-fat meals (>20 g fat/meal) are consumed. The absorption of fat soluble vitamins are reduced by orlistat but values never fell into the deficiency range. When fat soluble vitamins are supplied such as vitamin D, they should be ingested 2 hours prior to the ingestion of orlistat. More liquid stools may be beneficial for the many constipated elders but may also result in faecal incontinence in the elderly with an impaired internal and external sphincter function. The analysis of an older subpopulation of a 2-year randomised study in the primary care setting found that orlistat was just as effective in adults aged 65 and more as in younger adults (Hauptman et al. 2000, Segal et al 1999). Also the gastrointestinal side effects were not different in older than in younger subjects (Segal et al. 1999, Han et al. 2011).

Sibutramine, a selective noradrenaline and serotonin reuptake inhibitor, has been withdrawn from most markets after the SCOUT (Sibutramine Cardiovascular Outcomes) trial (James et al. 2010). More than 5800 overweight and obese patients were randomised to sibutramine or placebo for the study duration of 5 years. Mean age of the subjects was 63.2 years (range 55-88 years) and 33% were older than 65 years. Patients with cardiovascular disease and/or type 2 diabetes with at least one cardiovascular risk factor were enrolled. Enrolled patients were thus mainly older, very high-risk patients who fell outside the licence of the drug and were excluded from prior drug use according to the drug labelling. The risk of the primary outcome event (non-fatal myocardial infarction, non-fatal stroke or resuscitation after a cardiac arrest) was significantly higher in the sibutramine group (11.4%) than in the placebo group (10%). This outcome led to the withdrawal of the drug from the market. A more sound judgement would have been to leave it to the doctor to decide whether the clinical benefit of treatment to an individual patient, such as a substantial weight loss and a reduction in blood pressure, would balance against a possible 1% increase in myocardial infarction and stroke without an increase in mortality in at risk patients excluded under the licence of the drug.

Bariatric surgery
Bariatric surgery is indicated for subjects with severe obesity, i.e. with a BMI ≥ 40 kg/m^2 or a BMI ≥ 35 kg/m^2 with co-morbidity such as cardiorespiratory disease, diabetes, sleep apnoea and severe osteoarthritis, which are expected to improve by surgically induced weight loss. Age limitations between 18 and 50 by the NIH Consensus Conferences in 1985 and 1991 were widened over time to age 60 (NIH 1985, NIH 1991, Fried et al. 2007). With the improvement in intra-operative surgical management and optimalisation of peri-operative care, some centres offered bariatric surgery to patients who exceeded this age limit. Three centres reviewed retrospectively their data and although patient numbers were small (80 patients (age range 60.1-74.5) versus 2843 patients < 60 years of age; 23 patients (range 60-75 years) versus 527 < 60 years of age; and 20 patients (60-73 years) versus 110 < 60 years) they concur in their conclusions (Sugerman et al. 2004, Sosa et al. 2004, St Peter et al. 2005).
Older obese adults suffer from more co-morbidity and require more medications prior to

surgery than younger obese subjects. After open or laparoscopic gastric bypass a significant loss of excess weight of 60% after one year and of 50% after 5 years is noticed. This weight loss is associated with an improvement in obesity-related co-morbidity and an overall reduction in medication requirement. Younger adults, however, lost more weight and had a higher level of resolution of obesity associated diseases. One study had a slightly but significantly higher mortality without a difference in postoperative morbidity (Sosa et al. 2004). The 2 other studies reported a similar complication rate and a similar short length of 2-3 days of hospital stay (Sugerman et al. 2004, St Peter et al. 2005). None of the 3 studies provided data on the number of subjects in whom the surgeons declined to perform the operation because of major life-limiting processes or unacceptable cardiorespiratory risk factors or because surgical risks outweighed the expected benefits. Most of the enrolled subjects were females and according to a very recent study in veterans, sex difference should be taken into account (Macicjewski et al. 2011). No benefit in survival during a mean of 6.7 years of follow-up was observed in obese older males with obesity related co-morbidity, which could partly be explained by the shortness of follow-up but which might also be related to the fact that bariatric surgery appeared to be more difficult in large male patients.

Detailed nutritional aspects

Diet-induced weight loss results in both a decrease in fat mass and fat free mass with approximately 75% of the weight loss composed of fat tissue and approximately 25% composed of fat free mass. Therefore, weight loss in older persons could exacerbate the age-related loss of muscle mass and further impair physical function. Based on intensive research concerning sarcopenia and sarcopenic obesity, the already mentioned dietary guidelines were adjusted to prevent sarcopenic obesity and to guide the medical profession in their support of weight loss in the presence of sarcopenic obesity (Villareal et al. 2005, Miller & Wolf 2008, Zamboni et al. 2008, Paddon-Jones & Rasmussen 2009, Waters et al. 2010, Morley et al. 2010).

In healthy muscle, proteins and aminoacids constantly turn over with an equilibrium between protein synthesis and protein breakdown. Sarcopenia may be the result of increased rates of protein breakdown under the influences of cytokines produced in adipose tissue in a chronic state of low-grade inflammation. It may also be the consequence of diminished protein synthesis, which is partly due to the anorexia of ageing. Early satiety secondary to a decreased relaxation of the gastric fundus, an increased cholecystokinin release in response to fat intake, and increased leptin levels and declining testosterone levels in men may account for a decreased food and nutrient intake (Altman 1990, Lovat 1996, MacIntosh et al. 2000).
In the treatment of obesity, an energy deficit has to be created and in subjects with or being at risk of sarcopenic obesity, the energy deficit is more moderate than usual (500 kcal with a range of 200-750 kcal) with emphasis on a higher intake of proteins of high biological quality. When restricting the energy intake, protein intake has to be maintained or increased as dietary protein and aminoacids are the most effective means to slow or to prevent muscle protein catabolism. In order to optimize the anabolic response to ingested high-quality proteins certain peculiarities of the old age have to be taken into account (Paddon-Jones & Rasmussen 2009, Morley et al. 2010, Lovat 1996). In contrast to youngsters, the elderly has a diminished anabolic response to proteins when they are co-ingested with carbohydrates. There is no evidence that co-ingestion of protein and fat affects protein anabolism. So, ageing in itself does not reduce the anabolic response to sufficient amounts of high quality protein but it is the presence of carbohydrates that blunts this response, explained by the effects of insulin resistance on muscle protein synthesis. Therefore, a carbohydrate intake of less than 150

g/day is advised. A modest bout of physical activity such as 45 minutes of treadmill walking restores the ability of insulin to stimulate protein synthesis.

Also, protein intake should be strategically timed to overcome other consequences of ageing such as the blunting of the anabolic response due to changes in digestion, gastric emptying rate, splanchnic uptake and peripheral utilisation. Moreover, in contrast to the young, skeletal muscle in the old is not able to respond to low doses of protein and aminoacids (7 g), but 10-15 g of aminoacids are capable to stimulate protein synthesis to a similar extent as that of the young (Paddon-Jones & Rasmussen). A 110 g serving of lean beef with 30 g of aminoacids and 12 g of essential aminoacids increases muscle protein synthesis by 50%. One large serving of 340 g of lean beef with 90 g protein does not elicit a greater anabolic response than serving one-third the size and may be an energetically inefficient means to stimulate protein synthesis. The Recommended Daily Allowances for protein is 0.8 g/kg/day which means 60 g/day for a 75 kg person with 20 g protein and 5-8 g essential aminoacids per meal. As earlier demonstrated the requirements of protein to promote an anabolic response are higher in the elderly and the protein synthesis rate is maximally stimulated by the ingestion of 30 g of protein of high quality at each of the 3 main meals. Protein supplementation increases satiety which is a beneficial side-effect to reduce hunger in order to comply with an energy-deficient diet.

Other potential strategies to enhance protein synthesis are to include leucine in the diet from a minimum requirement of 2 g/day to an optimum of 6-8 g/day (Paddon-Jones & Rasmussen 2009, Layman & Walker 2008). Leucine-rich foods are legumes (soybeans) and animal products (fish, beef). Leucine increases protein anabolism and decreases protein breakdown. The addition of leucine to a mixed nutrient meal in older subjects resulted in an increase in muscle protein synthesis of 56% (Rieu et al. 2006). Leucine activates the signal cascade from phosphatidylinositol-4 kinase to mTOR (mammalian target of rapamycine) and activates the mTOR nutrient end energy sensing signalling pathway, resulting in increased protein synthesis initiation factors and increased protein synthesis in skeletal muscle (Paddon-Jones & Rasmussen 2009, Layman & Walker 2008). These findings have resulted in sip feedings enriched in hydroxymethylbutyrate, the active metabolite of leucine, to enhance protein synthesis in sarcopenic and malnourished elderly subjects.

Specific micronutrients that should be addressed are vitamin D, involved in protein synthesis, magnesium – hypomagnesemia is associated with insulin resistance –, and vitamin B_6, vitamin B_{12} and selenium which are associated with functional decline.

A 6-month intervention with a 440 kcal deficit diet and weekly behavioural therapy without a change in physical activity in 14 obese participants aged 71 years resulted in a 10% body weight reduction and a 16.3% decrease in fat mass and a 5.6% decrease in fat free mass (Shah et al. 2008). The endurance capacity and exercise tolerance examined by a treadmill stress test increased as did the cardiovascular and pulmonary efficiency. In these obese older adults with a low muscle mass relative to body weight (relative sarcopenia), the weight loss with a greater loss of fat mass (7 kg) than metabolically active muscle mass (2 kg) resulted in improvement in relative sarcopenia and improved endurance capacity and exercise tolerance. If these effects can be achieved just by a diet and behavioural therapy, why should one than add exercise to a diet?

Why adding exercise to a diet?

There are several reasons to add exercise to a diet:

- A hypocaloric diet (250-350 kcal deficit) and a hypocaloric diet plus exercise training (treadmill walking 45-60 min. 3 times per week at 65-70% of maximal heart rate (HR)) for 6 months resulted in a similar weight loss and loss of body fat and abdominal fat. With added exercise a higher basal and stimulated lipolysis was observed in abdominal and gluteal regions and serum levels of CRP, IL-6 and soluble receptors of IL-6 and TNF-α , indicative of chronic inflammation, decreased only when exercise was added to the diet (You et al. 2004)

- Frail old adults assigned to 6 months of a 750 kcal deficit diet and behavioural therapy or to a similar diet plus behavioural therapy plus exercise (90 min. 3 times/week, with 15 min. of balance training, 15 min. of flexibility, 30 min. low-impact aerobic exercise and 30 min. of high-intensity progressive resistance training) achieved a similar weight loss and loss of fat mass, but exercise added to the diet reduced the loss of fat free mass and lean tissue mass by 50% and increased muscle strength, suggesting an improved muscle quality by a decreased muscle fat infiltration as well as a reduction in inflammation. It completely prevented the loss of upper extremity lean mass and partly the loss of lower extremity lean mass (Frimel et al. 2008).

- Elderly obese patients with impaired glucose tolerance or diabetes type 2 were randomised into a weight loss group (500-1000 kcal deficit), or to a weight loss group combined with exercise (45 min. 5 times per week at 65-75% of maximum HR by treadmill, outside brisk walking or cycling). After 4 months body weight decreased significantly but similar in both groups (9.1%) with a similar decrease in BMI and fat mass. The addition of exercise resulted in an attenuated loss of fat free mass, lean muscle mass and normal density muscle mass and prevented the loss of type 1 high-oxidative muscle fibres and type 2 aerobic or glycolytic muscle fibres (Chomentowski et al. 2009).

- Elderly patients randomised to a 500-1000 kcal deficit diet with behavioural therapy and patients randomised to a similar diet with a slightly higher caloric intake to compensate for the exercise (900 kcal/week), behavioural therapy and exercise (90 min. 3 times per week at 85% of maximal HR and 80% of 1 RM (repetition maximum: maximal amount of weight that can be lifted once), consisting of 15 min. of balance training, 15 min. of flexibility, 30 min. of aerobic exercise and 30 min. of resistance training) achieved a similar weight loss, fat mass loss and fat free mass loss. The intrahepatic fat content decreased to a similar extent in both groups which was accompanied by a comparable improvement of insulin sensitivity. Improvements in endurance capacity, muscle strength, plasma triglycerides and LDL-cholesterol and diastolic blood pressure occurred in the diet plus exercise but not in the diet only group (Shah et al. 2009).

- Finally, a systematic review and meta-analysis of interventions to achieve long-term weight loss in obese older people (age ≥60 years, BMI > 30 kg/m^2, follow-up > 1 year) the highest mean difference in weight loss was obtained by a combined dietary advice and physical activity facility (Witham & Avenell 2010). Also, a greater decrease in serum total cholesterol was observed. Weinheimer et al. performed a systematic review of the separate and combined effects of energy restriction and exercise on fat free mass in middle-aged and older adults which is important for combating sarcopenic obesity (Weinheimer et al. 2010). The addition of exercise to energy restriction had no additive effect on the amount of weight loss, but clearly attenuated the loss of fat free mass. A 1995 meta-analysis in young and middle-aged adults revealed that exercise added to energy restriction reduced the percentages of weight loss as fat free mass from 25 to 12% (Garrow & Summerbell 1995). In the present meta-analysis the crude estimated fat free mass loss went down from 24% to 11% by the addition of exercise to the energy restricted diet.

Importance of physical exercise

The American College of Sports Medicine recommends a multi-component training exercise programme (strength, endurance, balance, flexibility) to improve and maintain physical function in older adults (Haskell et al. 2007). Resistance training has been investigated as an approach to counteract sarcopenia in older adults by stimulating protein synthesis and causing muscle hypertrophy with increased muscle mass and muscle strength and with improved physical functioning and performance of simple and complex activities in older people (Liu & Latham 2009). Endurance training alone improves aerobic capacity. The negative effects of concurrent strength and endurance training that might inhibit strength development when compared with strength training alone (Leveritt et al. 1999) and might negatively affect endurance adaptation (Leveritt et al. 2003, Tanakia & Swensen 1998) as suggested by some, could not be substantiated in the elderly (Davidson et al. 2009).

Frail old subjects were randomised to a balanced diet with an energy deficit of 500-750 kcal or to an exercise arm (90 min. 3 times/week, consisting of 15 min. of balance training, 15 min. of flexibility, 30 min. aerobic exercise at 80-90% of maximal HR and 30 min. of resistance training at 65% of 1 RM). After 12 weeks, body weight decreased in the diet group by 7.1% and not in the exercise group. Fat free mass decreased by 4.8% as a result of weight loss and increased by 2.7% as a result of exercise. Exercise but not the diet induced weight loss led to a significant decrease in cytokine expression (TNF-α, IL-6, toll-like receptor 4) in skeletal muscle and a significant increase of muscle growth factors and anabolism (Lambert et al. 2008).

The importance of a 3-month multi-component exercise training programme was investigated in nine 65-80-year old, moderately frail, obese older adults (Villareal et al. 2011). The multi-component programme consisted of 3 times/week 90 min. sessions, consisting of 15 min. of balance training, 15 min. of flexibility, 30 min. aerobic exercise and 30 min. of high intensity resistance training. Exercise had no effect on body weight or BMI but caused major changes in body composition such as decreased fat mass and increased fat free mass and appendicular lean mass. Endurance, muscle strength and functional mobility increased significantly. Adding multi-component exercise for 3 months resulted in a 50% higher basal and post-meal protein synthesis rate.

To study the impact of each exercise modality more in detail, Davidson et al. randomised 136 60 to 80-year old obese subjects into 4 groups: a control group, a group that had progressive resistance training for 3 times 20 min. per week, a group that performed aerobic exercise for 5 times 30 min. per week on a treadmill (60-75% of maximal HR), and a group that combined 3 times 20 min. of progressive resistance training with 3 times 30 min. of aerobic exercise (Davidson et al. 2009). After 6 months, body weight decreased by 0.6 kg in the resistance and by 2.8 kg in the aerobic and 2.3 kg in the combined exercise group. Total fat decreased significantly in the aerobic exercise and combined exercise group compared to the control and resistance groups. Abdominal fat and visceral fat decreased in the aerobic and combined exercise group compared to the control group. Skeletal mass increased in the resistance and combined exercise groups only and also muscle strength improved here. Endurance capacity improved with 18% in the aerobic and combined exercise group. Insulin resistance improved by 31% in the aerobic group and by 45% in the combined exercise group whereas it did not change in the resistance training group. The fear of a negative interference of endurance and resistance training was not substantiated and the combination of progressive resistance training and aerobic exercise is the optimal exercise strategy for simultaneous improvement of insulin resistance and functional limitations in the elderly. As a considerable improvement was noticed in response to aerobic exercise, this is a second best choice.

3 meta-analyses examined the effects of physical activity on health-related quality of life in older adults. None of these meta-analyses performed a separate sub-analysis with respect to the presence of normal weight, overweight or obesity.

Schlechtman & Ory examined the Frailty and Injuries: Cooperative Studies of Interventional Techniques (FICSIT), a linked series of randomised trials focussed on the benefits of exercise in the frail elderly (mean age 73.4 years)(Schlechtman & Ory 2001). Of the 4 SF-36 subscales, an improved emotional health with a trend toward improved social functioning was associated with physical activity. A meta-analysis of 36 studies in subjects without clinical disorders (mean age 66.4 years), 4 components of quality of life were examined (Netz et al 2005).

Psychological well-being was significantly improved and self-efficacy, overall well-being and view-of-self tended to be improved in physically active subjects. Kelly et al. included in their meta-analysis 11 studies of community-dwelling older adults (mean age 72.4 years)(Kelly et al. 2008). They considered all SF-36 scales and found that physical activity improved the self-reported physical function.

Why adding a diet to exercise?

As a small weight loss with beneficial effects on body composition and insulin resistance can be obtained by exercise only, the question remains why a diet should be added to exercise. When 24 older obese adult with the metabolic syndrome were randomised into a group with only exercise (50-60 min. 5 times per week at 85% of maximal HR) or into a group with a similar exercise and a reduced energy intake by 500 kcal, similar improvements of all components of the metabolic syndrome occurred in the short term of 12 weeks, but the combination resulted in greater weight loss and subcutaneous fat mass loss (Yassine et al. 2009).

In a larger study 288 older, obese adults with poor cardiovascular health entered into a study with 3 treatment arms: a successful ageing control arm, a physical activity arm (30 min. of moderately intense activities 5 times a week) and a weight loss (1200-1500 kcal diet when <250 lb and 1500-1800 kcal diet when >250 lb) and physical activity arm (Rejeski et al. 2010). The first 6 months formed the intensive weight loss phase, month 7-18 formed the weight maintenance phase. In the combined weight loss and physical activity group subjects were losing more weight, were better able to maintain the lost weight and had the best physical performance on a 400 m walk test. The 400 m walk test predicts multiple adverse outcomes such as morbidity, worsening disabilities, cardiovascular disease, institutionalisation and mortality.

Lifestyle intervention: feasible in the frail elderly?

In several small clinical trials, the group of Villareal et al. from Washington randomised 27 obese and frail subjects to a control group and a group receiving lifestyle intervention. Lifestyle intervention consisted of a 750 kcal deficit energy-restricted diet, behavioural modification and a multi-component exercise programme, 3 times 90 min. per week. These studies were of short, 6 months' duration. In subjects with coronary heart disease and the metabolic syndrome, the intervention group achieved a greater weight loss and fat mass loss with significant improvements in all the components of the metabolic syndrome, and in CRP and IL-6 blood levels (Villareal et al. 2006). In frail subjects the intervention reversed frailty, increased muscle strength and quality and improved the static and dynamic balance tests (Villareal et al. 2006). Lifestyle intervention improved the pancreatic β cell and α cell function, increased the insulin clearance and doubled the insulin sensitivity (Villareal et al. 2008). The only adverse effect consisted of an increased bone turnover and a 2-3% decrease of hip bone mass after 1 year (Villareal et al. 2008). Very recently, Villareal et al. reported the results of a larger group of 107 frail obese elderly subjects followed for one year (Villareal et al. 2010). Patients were randomised into a control group, a diet group with a 500-750 kcal deficit diet with 1 g protein/kg/day, an exercise group (90 min. 3 times a week, with 15 min. of flexibility training, 30 min. of aerobic exercise at 85% of maximal HR, 30 min. of resistance exercise at 80% of 1 RM, and 15 min. of balance training) and a combined diet plus exercise group. All subjects received a supplement of 1500 mg calcium and 10 mcg vitamin D. Compared to the control group, diet and weight loss alone and exercise alone could reverse the state of frailty, but the combination of diet and exercise was more effective than either individual intervention alone. The highest values for the physical performance tests, functional status questionnaire and aerobic endurance capacity on the treadmill were obtained in the combined group. Both the diet group and the diet plus exercise group performed equally well in the loss of body weight and fat mass loss. The quality of life improved and the only potential adverse effect was a small reduction in lean body mass and bone mineral density in the diet group (-5% and -2.6%, respectively) and in the diet plus exercise group (-3% and -1.1%, respectively).

In the Arthritis, Diet, and Activity Promotion Trial (ADAPT) 316 patients older than 60 years of age with osteoarthritis of the knee were randomised into 4 groups of healthy lifestyle, diet only (dietary goal 5% weight loss after 18 months), exercise only (60 min. 3 times per week; 15 min. aerobic training, 15 min. resistance training, 15 min. aerobic training and 15 min. cool down), and a diet plus exercise group (Messier et al. 2004). The weight loss was significantly greater in the diet only and the combined diet-exercise group. All improved in function but knee function, the 6 minute walk test and the stair climbing test improved the most in the diet plus exercise group. Pain scores were 6% less in the exercise group, 16% less in the diet group and 30% less in the diet plus exercise group. These beneficial results became already apparent after 6 months and remained present during a further 12 months of the study. Eight years later, they re-analysed their data and obtained death certificates of the deceased participants (Shea et al. 2010). For the first time they could demonstrate that intentional weight loss in the elderly was not associated with increased overall mortality. On the contrary, a 50% lower mortality was found in the groups randomised to weight loss (diet and diet plus exercise) compared to the groups not randomised to weight loss (healthy lifestyle and exercise).

Barriers and perceived constraints to participate in physical exercise

The Screening and Counselling for physical Activity and Mobility in Older People (SCAMOP) study examined 619 subjects of 75-83 years old and a BMI between 20 and 53 kg/m^2 (Sallinen et al. 2009). The objective was to examine what they felt as constraints to exercise and whether these perceived constraints explained the increased risk of physical inactivity. Compared to the non-obese elderly (BMI 20-29.9 kg/m^2), the moderately obese (BMI 30-34.9 kg/m^2) had twice the risk of inactivity and the severely obese (BMI $\geq$ 35 kg/m^2) 4 times the risk of inactivity. Poor health, pain, diseases and tiredness explained 27% of the increased risk of physical inactivity. Fear and negative experiences such as the fear of falling, the fear of injury, exercise experienced as uncomfortable and insecurity when exercising outdoors contributed 23% to the increased risk of inactivity. All these factors entered in the model together with the item of having no interest in exercise explained 42% of the increased risk of physical inactivity, leaving 58% unexplained. These factors were substantially more frequent among the severely obese.

A meta-analysis of 43 studies in 33 090 60-70 year olds rejected the hypothesis that interventions to increase physical activity do not affect the activity among older adults (Conn & Valentine 2002). Several modulating factors were found that can be used to increase the physical activity amongst elders. One should only target physical activity and not couple this to health education. Also, one should focus on group activity, encourage moderate exercise intensity and activity, incorporate self-monitoring, and encourage centre-based activities with an intense contact with the interventionists at a structured time.

Conclusion

Obesity is a major public health problem. The prevalence of obesity in the elderly is rising. Derived from figures from the period 1960-2000 a projected increase in the prevalence of obesity in adults 60 years and older is to be expected from 14.6 million (2000) to 20.9 million (2010) or from 32% to 37.4%. This is far from the goals of Healthy People 2010, a prevention agenda for the USA, that set goals for the prevalence of obesity (BMI > 30 kg/m^2) and normal weight (BMI < 25 kg/m^2) for persons 60 year and older as 15% and 60%, respectively. Ageing and obesity are two conditions that represent an important part of health-care costs. An increasing obese elderly population will undoubtedly offer growing financial problems.

Although cut-off values of BMI, waist circumference and percentages of fat mass have not been defined for the elderly, it is clear from several meta-analyses that mortality and morbidity associated with overweight and obesity starts not before a BMI of 30 kg/m^2 in the elderly. Treatment should only be offered to patients who are obese and who have functional impairments, metabolic complications or obesity-related diseases, that can benefit from weight loss. The weight loss therapy should minimize muscle and bone loss and vigilance as to the development of sarcopenic obesity should always be present.

Lifestyle intervention is the first step and its effects are well studied in the obese elderly. This consists of a diet with a 500 kcal energy deficit and an adequate intake of protein of high biological quality, together with calcium and vitamin D, behavioural therapy and multi-component exercise. Multi-component exercise includes flexibility training, balance training, aerobic exercise and resistance training. The adherence rate in most studies is around 75%. Knowledge of constraints and modulators of physical inactivity should be of help to engage the elderly in physical activity. The role of pharmacotherapy and bariatric surgery in the elderly is largely unknown as in most studies people aged 65 years and older were excluded.