2018 SCOR inFORM

OBESITY
THE HEALTH CHALLENGE OF THE 21ST CENTURY

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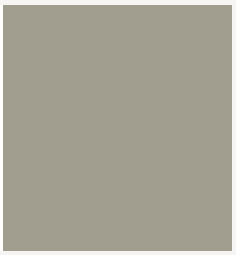
Introduction

For the first time in history, there are more people suffering from obesity than from starvation worldwide. A tremendous increase in the number of obese people has taken place in developed countries and is starting to be seen in the emerging countries as well.

In 2005, the World Health Organisation (WHO) estimated that approximately 1.6 billion adults were overweight and at least 400 million adults were obese (Ref. 1). By 2015, these numbers had greatly increased: approximately 2.3 billion adults were overweight, and more than 700 million people were obese.

This document is intended to enable a better understanding of the medical issues around obesity and its impact on the body as well as the potential consequences on personal insurance.



Obesity - the health challenge of the 21st century

Definition

The WHO defines overweight and obesity as "abnormal or excessive fat accumulation that presents a risk to health". Direct measurement of body fat in an individual is complicated and involves the use of costly, sophisticated methods such as magnetic resonance. In practice, diagnosis is done by an indirect method: the calculation of body mass index (BMI), which is the ratio between the weight in kilograms and the height in metres squared: BMI = weight (kg)/ height $(m)^2$.

According to most international medical organisations, the BMI criteria for normal weight, overweight and obesity are defined as follows:

- Between 25 and below 30, the person is considered as being overweight or pre-obese
- Between 30 and below 35, obesity is classified as moderate (class I)
- Between 35 and below 40, obesity is classified as severe (class II)
- Finally, when the BMI is over 40, it is classified as morbid obesity (class III), as super obesity over 50 (class IV) and as super-super obesity over 60 (class V).

Asian populations generally have a higher percentage of body fat than Caucasian people of the same age/BMI, and the complications therefore will be present at a lower BMI on average. Consequently, lower BMI values have been proposed to determine the threshold for overweight and obesity classifications within Asian populations: BMIs of 23 and 25 respectively.

OBESITY CLASSIFICATION BY BMI

NORMAL RANGE	18.50 - 24.99
OVERWEIGHT	**≥ 25.00**
Pre-obese	25.00 - 29.99
OBESE	**≥ 30.00**
Obese class I	30.00 - 34.99
Obese class II	35.00 - 39.99
Obese class III	≥ 40.00
Obese class IV	≥ 50.00
Obese class V	≥ 60.00

An increase verging on a "pandemic"

BMI is now the universal measurement used for the classification of obesity. Studies and epidemiological comparisons of obesity in each country have become possible and have shown the following observations: during the last 20 years, the increase in obesity has been substantial, wide-ranging and rapid. It affects the entire world irrespective of age, income and country. While the United States, Australia and the United Kingdom are still at the top of the list of countries affected, the countries that have seen the biggest increase in the number of obese and overweight people are in the Middle East and North Africa. In China, the proportion of men who are overweight has been increasing by 1.2% annually every year for the last 10 years. If nothing is done to slow the pace, the total number will have doubled by 2028.

Even though the US has the largest number of obese people, other countries like Mexico and the UK are close behind FIGURE 1. Meanwhile, countries like Japan, Italy and France have not followed this trend as closely. Generally speaking, over 50% of men over 50 years old are overweight or obese worldwide.

Projections for the future FIGURE 2 show that obesity rates are expected to continue to rise in a linear fashion, particularly in the US, Mexico and England where 35-50% of the populations are expected to be obese by 2030 (Ref. 2). These rates are also expected to increase more dramatically in countries with historically low obesity rates, such as Switzerland and Korea.

FIGURE 1: OECD OVERWEIGHT (INCLUDING OBESITY) RATES IN ADULTS AGED 15-74

Note: Overweight and obesity rates designate overweight and obesity prevalence rates. Age- and gender-adjusted rates of overweight (including obesity), using the 2005 OECD standard population. Measured height and weight in England, Hungary, Korea, Mexico and the United States; self-reported in other countries.

Source: OECD analysis of health survey data.

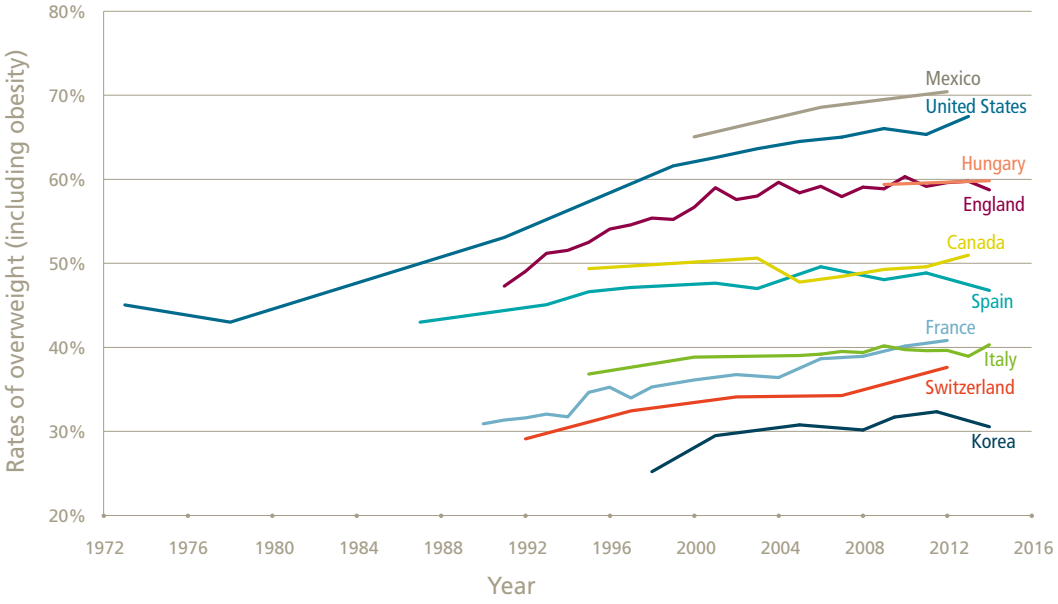
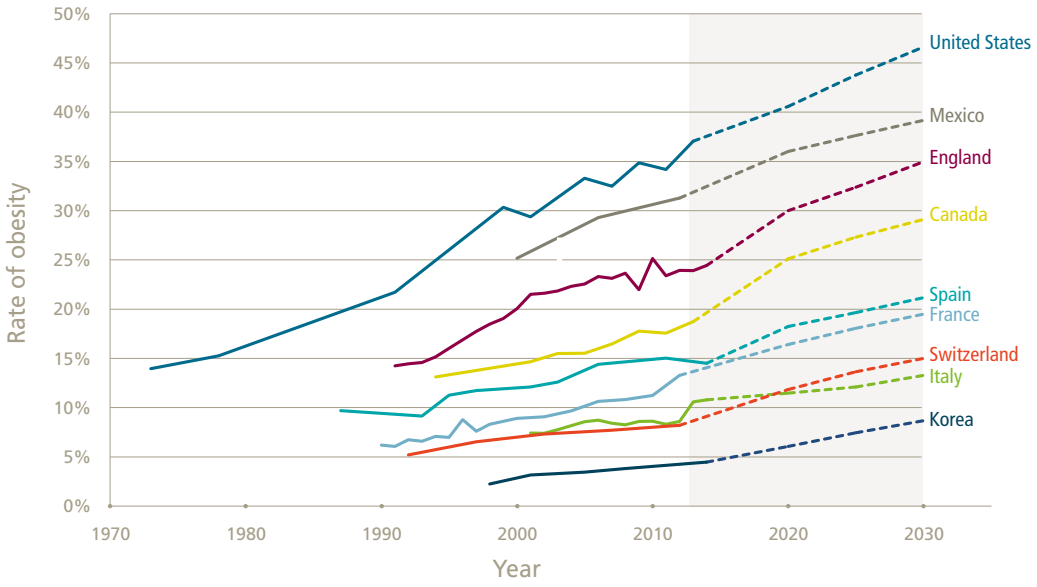


FIGURE 2: OECD PROJECTED RATES OF OBESITY

Note: Obesity defined as Body Mass Index (BMI) ≥30kg/m². OECD projections assume that BMI will continue to rise as a linear function of time.

Source: OECD analysis of national health survey data.



OBESITY IN CHILDREN

From the late 1970s onward, we have seen an increase in the number of children who are overweight (ages 5 – 11 with BMI > 85 percentile). In the US, the childhood obesity rate was approximately 15% in the 1970s and had doubled by the 2000s. This trend has also been seen in most developed countries, but importantly, it is being seen in developing countries such as Africa, where the number of obese children has doubled in the last 20 years (Ref. 3). In many of the Mediterranean countries like Malta, Portugal and Italy, childhood overweight/obesity rates are over 30%, primarily due to the abandonment of the traditional Mediterranean diet.

Globally, there were 42 million overweight or obese children in 2013 (Ref. 3). If this trend continues, this number will rise to 70 million by 2025, which could have an enormous impact on insurance companies that do not anticipate and plan for pricing changes.

Causes

Obesity is the result of a prolonged disproportion in the balance of energy: energy intake exceeding energy expenditure. Three main factors combine to arrive at this imbalance.

GENETIC FACTORS

Some 50 genes connected to obesity have been identified, and it is now known that there are "obesogenetic" predispositions at play. For example, certain genetic mutations mean that some people do not secrete leptin, which is the hormone of satiety. In fact, experts prefer to describe these types of predispositions using the term "genetic susceptibility", that is to say that in an environment which favours the development of obesity, these genetic factors increase the possibility of people becoming obese.

ENVIRONMENTAL FACTORS

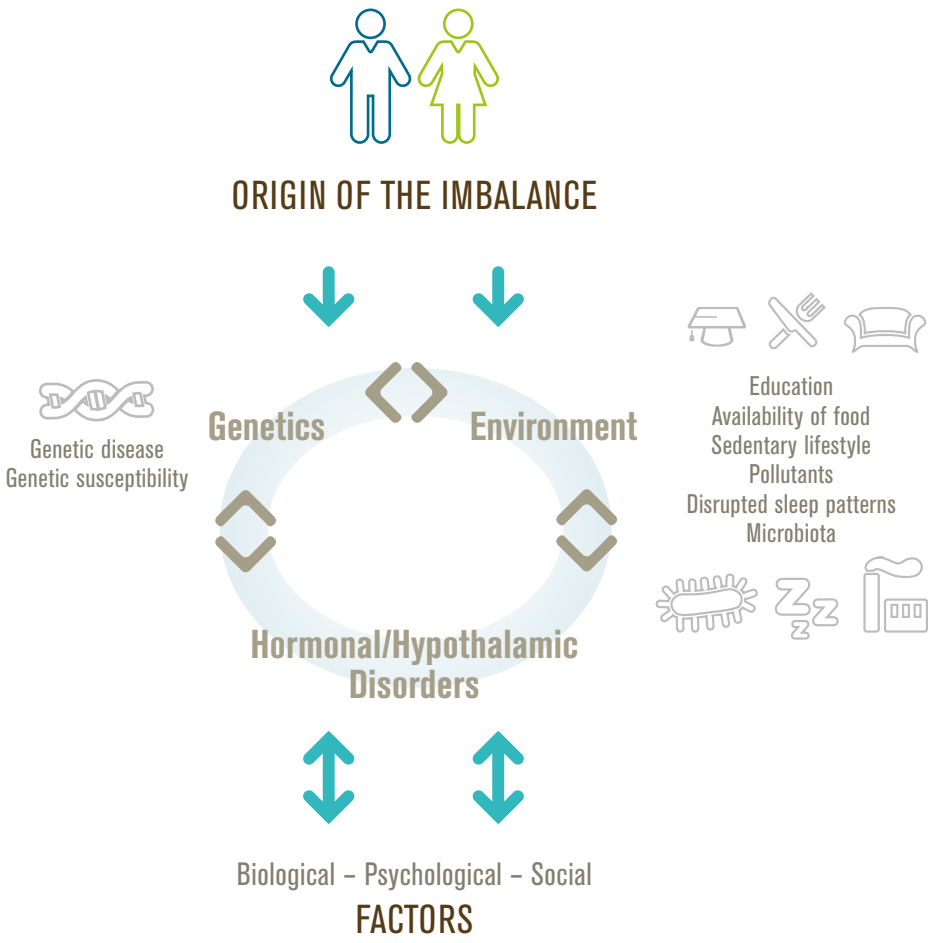
Certain situations can favour obesity: low education, high availability of food, sedentary lifestyle, certain pollutants, gut microbiota, certain drugs and poor sleep patterns.

HORMONAL FACTORS

Thyroid insufficiency and menopause are two of many factors which frequently coincide with a weight gain.

FIGURE 3: WHY DO WE BECOME OBESE?

Source: Paris Diderot University – Bichat-Claude Bernard Hospital



GENETICS

The hereditary element of obesity can be passed on from generation to generation.

In a study, the second-generation descendants of mice that were fed a high-fat diet became fat even if themselves and their own mother was fed a normal diet. Epigenetic changes have the potential to be passed down several generations, which might sustain and magnify the obesity epidemic.

As an example, a long-term, high-fat diet decreases methylation of the MCR-4 receptor gene, which could stimulate appetite in affected individuals and persist in their offspring (Ref. 4).

Consequences and comorbidities

Obesity is the direct or indirect cause of a large number of illnesses, the most serious of which are: Type 2 diabetes, coronary heart disease, cerebrovascular incidents (strokes and transient ischemic attacks) and cancers. Obesity can also be associated with many other conditions such as respiratory impairment, sleep apnoea, bone and joint illnesses - the main one being osteoarthritis - and psycho-social problems such as depression (which are both a cause and a complication).

Complications also result from obesity such as certain skin diseases, digestive disorders, pancreatitis, biliary diseases, and hypertension. All these risks are considerably increased with obesity. The risk of sleep apnoea syndrome is multiplied by 7.5, that of osteoarthritis of the knee and hip increases 2.9 times, and asthma and urinary incontinence both increase by 1.8 times. It should be noted that there are three times more Type 2 diabetics and people diagnosed with hypertension among the obese.

CARDIOVASCULAR RISK

In terms of frequency and implication in obesity-related deaths, the most important are the associated cardiovascular complications, in particular atherosclerotic complications. The development of atheromatic plaques interferes with the functioning of organs, causing heart failure, ischemic strokes, arterial disease of the lower limbs and other problems.

Hypertension-related complications are also common (haemorrhagic stroke, hypertensive retinopathy, nephroangiosclerosis, hypertrophic cardiomyopathy), as well as heart failure, which can have several origins in the obese person: ischemic, hypertensive, pulmonary. Venous complications can also be linked to obesity: phlebitis, pulmonary embolism, venous insufficiency, varicose veins and venous ulcers.

The notion of cardiovascular risk originated in Framingham (US) in 1948. The first results from the study of the same name date from 1961 listed the main risk factors involved in the development of heart disease. The analysis showed that cardiovascular risk follows a multiplicative and not an additive model – meaning that risk factors have a multiplying effect on each other, rather than simply the sum of the two risks.

The Framingham model led to the development of risk equations intended to assess absolute cardiovascular risk (ACVR). These include different parameters such as gender, age, systolic blood pressure, total cholesterol, HDL cholesterol, tobacco consumption, diabetes, left ventricular hypertrophy and family history.

Another equation, based on the European SCORE risk prediction model, calculates a risk of cardiovascular death within the next 10 years, based on different risk factors including gender, age, arterial pressure, cholesterol and tobacco consumption.

METABOLIC SYNDROME – CARDIOMETABOLIC RISK

BMI alone, in a certain number of situations, is not a sufficient marker to detect an excess of body fat that could be detrimental to health. Hence the need to look for what the WHO refers to as "bad fat", which can help identify metabolic syndrome. This notion of "bad fat" rests on the idea that a certain type of fat is especially toxic: visceral (or abdominal) fat, which is situated in the abdomen, as opposed to subcutaneous fat.

The possibility of measuring the relationship between visceral fat and cardiovascular risk is quite new. This visceral fat, however, represents an independent risk factor, which comes in addition to the factors already identified: BMI, age, gender, hypercholesterolemia, ethnic origin and tobacco. This is in addition to more recently identified markers such as inflammation or insulin resistance. Waist circumference can provide an approximate evaluation of this excess fat.

Another type of fat is also harmful to health: ectopic fat. This is fat which is no longer situated in the adipose tissue, but instead is found in the kidneys, blood vessels, pancreas, pericardium, epicardium, neck, muscles, etc. This fat will cause inflammation, insulin resistance, oxidative stress, secretions of toxic substances by the liver, resistance anomalies in the vessels and more. All these metabolic and inflammatory disturbances will favour the occurrence of Type 2 diabetes, liver disease (NASH), obstructive sleep apnoea syndrome and polycystic ovary syndrome.

Metabolic syndrome is therefore characterised by an excess of visceral and ectopic fat, leading to various disturbances and increasing the risk of developing cardiovascular disease.

> "Cardiometabolic risk should therefore be assessed in every adult, taking into consideration both traditional risk factors and the presence or otherwise of metabolic syndrome."

ABDOMINAL OBESITY

The fat situated around the abdomen is indeed considered as particularly toxic, producing a predisposition to a certain number of metabolic diseases. Measuring the waist circumference is recommended for a BMI between 25 and 35 inclusive, and several thresholds have been defined, which are different for men and women.
This waist measurement constitutes an external indicator suggesting a possible excessive and abnormal accumulation of fat around the abdomen.
BMI and waist circumference are therefore both external warning signs. In practice, the measurement of waist circumference is little used by insurers because it requires an examination by a doctor or nurse to make the measurement.

A diagnosis of metabolic syndrome is made when an individual meet at least three of the five criteria shown in FIGURE 4. These anomalies, whenever they are combined, are evidence of an excess of body fat that could be harmful to health.

The concept of cardiometabolic risk corresponds to the risk of developing a cardiovascular disease and/or Type 2 diabetes. It results from the combination of traditional risk factors for cardiovascular diseases and the presence of potentially toxic visceral fat.

Over long periods of time, which can vary from 5 to 20 years, the effect of metabolic syndrome has proven to be more difficult to estimate than that of hypertension, diabetes, asthma, gender or tobacco consumption. This helps explain the discrepancies between studies seeking to find out whether adding this syndrome into the overall risk equation adds to the predictive ability or not. Despite these uncertainties, the cardiovascular risk is weighted according to the presence or not of metabolic syndrome. Patients without this syndrome are considered as low cardiovascular risk and would be classified as an intermediate cardiovascular risk if they have metabolic syndrome. This method gives doctors a better evaluation of the absolute risk over time in order to adapt the therapeutic management.

Cardiometabolic risk should therefore be assessed in every adult, taking into consideration both traditional risk factors and the presence or otherwise of metabolic syndrome.

FIGURE 4: DEFINITION OF METABOLIC SYNDROME

CONDITION	CRITERIA
ANY 3 OF THE FOLLOWING 5 CRITERIA	
Hyperglycemia	Fasting glucose ≥100 mg/dL (or receiving drug therapy for hyperglycemia)
Hypertension	Blood pressure ≥130/85 mm Hg (or receiving drug therapy for hypertension)
Triglycerides	Triglycerides ≥150 mg/dL (or receiving drug therapy for hypertriglyceridemia)
Cholesterol	HDL-C <40 mg/dL in men or <50 mg/dL in women (or specific treatment for this lipid abnormality)
Abdominal obesity	Waist circumference: • ≥102 cm (40 in) in men or* • ≥88 cm (35 in) in women* **In some populations, such as those of Asian descent, population and country-specific definitions are used*

Source : IDF (International Diabetes Federation)

Medical, paramedical and preventive treatments

DIET AND PHYSICAL EXERCISE

On the diet side, the most representative study compared the effectiveness of three low-calorie diets: the low-carbohydrate (high-protein) diet, the low-fat diet and the Mediterranean diet. In a population of class I obese subjects. with a BMI of 31, the results show that, over the long term, the Mediterranean diet and the low-carbohydrate diet are more or less equivalent. The weight loss obtained is generally 4% to 5% of original body weight.

Drugs that cause weight loss are rare. The oldest of them, Orlistat (Xenical©), acts by preventing the absorption of fats. More recently, in 2014 and 2015, two other medicines have been authorised by the European Commission: the first is an anorectic drug, a combination between naltrexone and bupropion (Contrave©), and the second is an analogue of Glucagon-like Peptide 1 (GLP-1) liraglutide (Saxenda©), which is already used to treat diabetes.

Currently, the basic treatment for obesity is therefore through diet. Calorie restriction combined with physical exercise allows a 5% to 10% weight loss, most often only transiently. Drug treatments increase effectiveness at the cost of certain side effects such as diarrhoea, incontinence, nausea and dizziness.

The response to cardiometabolic risk includes measures to prevent diabetes and cardiovascular diseases in at-risk subjects. Several studies have provided an answer to the question of diabetes prevention, the most classic one being the DPP (Diabetes Prevention Program) study, which compares three strategies in people recruited at the stage of prediabetes:

- Strict diet and lifestyle measures (DLM), consisting of a low-calorie low-fat diet, coupled with regular physical exercise of more than 150 minutes a day, with monitoring
- Taking metformin (standard treatment for diabetes), with classic DLM recommendations and annual follow-up
- A placebo, classic DLM and annual follow-up

The results are clear. They showed the efficacy of the first model, which reduces the risk of becoming diabetic by 58%. The DPP has been re-evaluated long term, showing conclusively that 10 years later the initial benefit was maintained, with a 34% reduction in the risk of becoming diabetic.

To control early diabetes, the most effective diet is therefore the Mediterranean diet, which is based on the consumption of fish, olive oil, walnuts, almonds, fresh fruit, fresh vegetables and white meat. This diet reduces the need for oral anti-diabetic drugs when compared to a low-fat diet.

It is also possible to prevent cardiovascular diseases in at-risk subjects. Several studies have confirmed that the Mediterranean diet is again the most effective here.

Physical fitness is also essential. Whatever the amount of visceral adipose tissue, exercise and fitness play an important role in the prevention of metabolic syndrome. There is also a link between sleep, metabolic syndrome and diabetes, with the optimum number of hours' sleep being between six hours and nine hours.

Non-drug treatment of cardiometabolic risk therefore rests on the Mediterranean diet (loss of 7% of body weight by reducing calories), physical activity and good management of sleep patterns.

In terms of the **drug treatment** of metabolic risk, the treatments target diabetes, hypertension, cholesterol (the more LDL cholesterol is reduced, the more the cardiovascular risk is reduced in people with a high risk). Drug treatments are indicated in the presence of a high-risk factor and/or a high cardiovascular risk.

Surgical treatment of obesity: bariatric surgery

Despite the many kinds of diets possible, currently the best weight loss outcomes in the long term for people with severe/morbid obesity (BMI > 40) are seen with bariatric surgery. Bariatric surgery is based on two main mechanisms: techniques based on reducing the capacity of the stomach and mixed techniques, which combine stomach pouch reduction with a gastric bypass.

Bariatric surgery is the only effective treatment for morbid obesity. It leads to a reduction in long-term morbidity, thanks to beneficial effects on hypertension, diabetes, dyslipidemia, sleep apnoea and bone and joint disorders.

These operations have seen strong growth all over the world, and today there are more than 200,000 bariatric operations per year in the US (with sleeve gastrectomy being the most common) and over than 95,000 in Brazil. France is ranked third in the world, with almost 50,000 operations, three times more than 10 years ago.

A LONG ROAD BEFORE BARIATRIC SURGERY

For an obese individual, the road to surgery is a long one. In fact, patients must meet two essential criteria: stable and longstanding obesity (over five years) and a BMI above 40 - or over 35 in the presence of associated comorbidities (hypertension, diabetes, dyslipidemia, sleep apnoea or bone and joint disorders and metabolic syndrome).

In Asia, the thresholds are different. Obesity is considered as morbid from a BMI of 35 and from a BMI of 30 in subjects with associated comorbidities. In keeping with this trend, metabolic surgery (in cases of Type 2 diabetes) can be considered in this population for BMIs of between 25 and 30.

Candidates for bariatric surgery are often entrusted to multi-disciplinary centres specialising in the medical and surgical treatment of these patients and to teams working in a network of several different health professionals including surgeons, nutritionists, dieticians, endocrinologists, psychiatrists, gastro-enterologists, etc. Monitoring before and after the operation will involve all members of the team, working in close collaboration with the patient's primary physician. They are all involved in monitoring the changes in the patient's weight and for treating any complications.

> “Patients must meet two essential criteria: stable and longstanding obesity (over five years) and a BMI above 40 - or over 35 in the presence of associated comorbidities.”

Surgical treatment of obesity: bariatric surgery

Different types of surgery exist.

SLEEVE GASTRECTOMY

Sleeve gastrectomy is the most recent technique and the most commonly used method over the last five years as it is replacing other surgical techniques FIGURE 6.

It consists of a 4/5 gastrectomy (removal of 80% of the stomach), leaving a small stomach pouch - with a volume of approximately 100ml - which empties naturally into the duodenum. In addition, this technique involves the removal of the upper part of the stomach (the fundus), leading to decreased concentrations of ghrelin, the hunger stimulating hormone.

The rate of early complications after a sleeve gastrectomy is 1.4% to 15%: these include fistulas, haemorrhages and other medical complications.

The mortality rate is less than 1%. There can also be late complications: fistulas occurring up to one-year post-operation, gastro-oesophageal reflux, incisional trocar port hernias and cases of iron and vitamin deficiency. These can lead to re-operation but still less than with bypass surgery.

GASTRIC BYPASS SURGERY

Gastric bypass surgery consists of reducing the volume of the stomach and reroutes the path taken by food FIGURE 7.

Food no longer passes through the stomach and the top part of the digestive tract, but goes directly into the middle section of the small intestine.
The stomach is bypassed, with a very small portion of the upper stomach linked to the jejunum. This leads to poor absorption of certain foods, fats in particular, resulting in weight loss.
Most of the stomach, which the food no longer enters, is left in place.

The rate of early complications after gastric bypass surgery is 10% on average (staple line leaks, fistulas, anastomotic stenosis, small bowel obstructions and other medical complications).

The mortality rate is usually less than 1%. Late complications are also possible: bowel obstruction caused by adhesions or internal hernias, anastomotic stenosis or ulcers, incisional trocar port hernias, iron and vitamin deficiencies. These lead to quite a high rate of surgical re-intervention.

GASTRIC BAND

Gastric band: This type of surgery consists of placing an easily adjustable silicone band (connected by a tube to a control box under the skin) around the upper part of the stomach, separating the latter into two pouches FIGURE 8.

The band has a restrictive effect, reducing the volume of the stomach and slowing the passage of food.

This technique requires discipline on the part of the patient, who will need to chew food slowly and well, avoid simple carbohydrates/fats and abstain from drinking during meals. Weight gain is common after this procedure, and this technique involves a failure rate of about 33%.

The mortality rate is less than 1% and the average rate of complications is about 5% (band slippage, stomach perforation, pulmonary embolism and respiratory complications).

In addition, there is a 17% rate of late complications: band slippage, pouch dilation, intragastric band migration, problems with the control box and food intolerance.

FIGURE 5 **STOMACH**

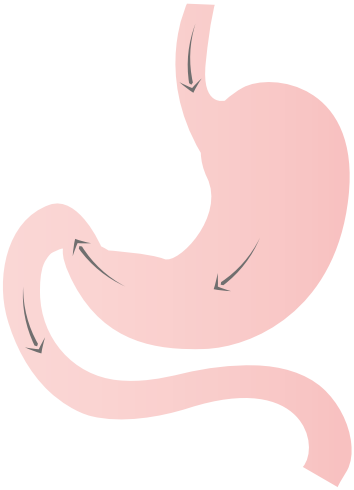


FIGURE 6 **SLEEVE GASTRECTOMY**

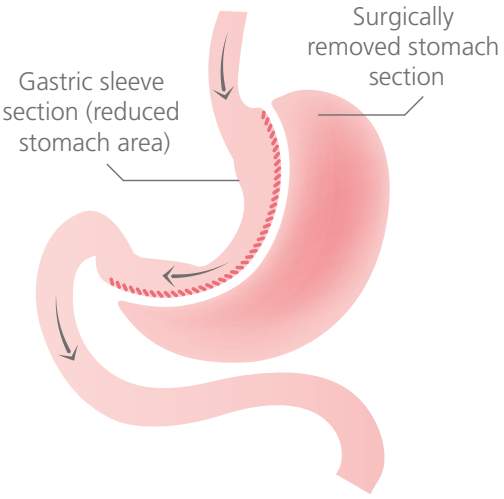


FIGURE 7 **GASTRIC BYPASS SURGERY**

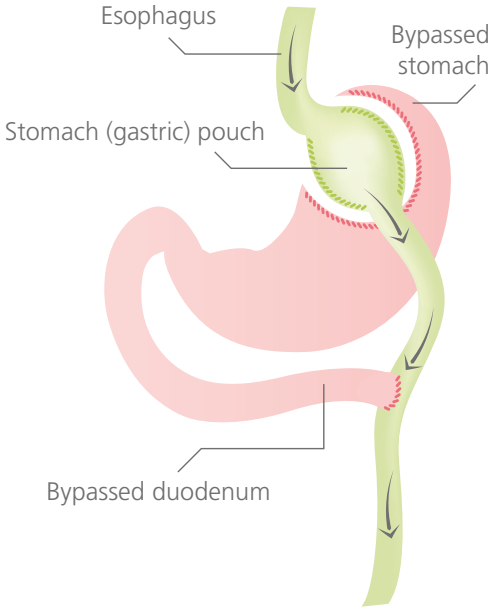
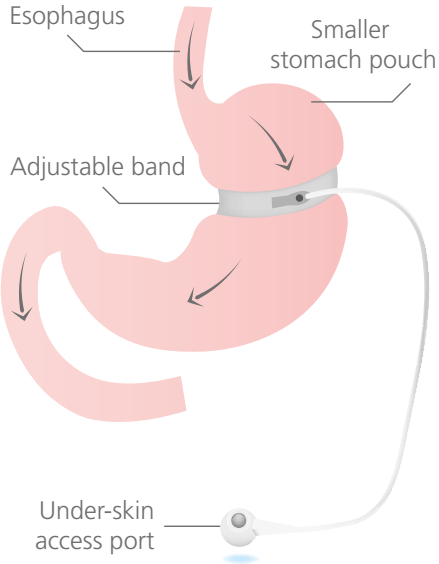


FIGURE 8 **GASTRIC BAND**



Obesity and insurance

MORTALITY AND RATING

MORTALITY

Globally, all studies looking at all-cause mortality show an excess risk of death from a BMI of 30 upwards, which is more marked from a BMI of 35 and even higher once BMIs increase above 40. The leading causes of mortality are cardiovascular and cerebrovascular, primarily myocardial infarction and stroke. The Lancet published a meta-analysis in 2016 of 239 BMI studies on four different continents. In this study, it was found that the mortality increased linearly with BMIs over 25 and that this impact was more significant in younger people than in people over 70 years of age. Similarly, some studies show that for the same BMI, there is a significantly higher rate of mortality in men than in women.

RATING

The initial approach to the rating of obesity in life insurance is simple: simply adjust the excess mortality to the curves of the all-cause mortality according to BMI. This will show the excess mortality rates increasing progressively depending on sex and BMIs.

In practice, it must be recognised that obesity is a parameter often associated and merging with other cardiovascular risk factors: hypertension, dyslipidemia and diabetes, in particular. A simple addition of the excess mortality due to these anomalies overestimates the overall rating for mortality and leaves room for weighting of the raw mortality statistics according to BMI.

The two consequences on rating for insurance purposes are:

- Not applying any additional rating when the BMI is < 35 to avoid applying a "double penalty" if obesity is associated with other cardiovascular risk factors.
- Including obesity in a cardiovascular risk calculator that automatically takes into account and appropriately weights BMI, blood pressure, the cholesterol/HDL ratio and the age of the applicant to arrive at an excess mortality adapted to that of large primary prevention cohorts such as PROCAM and FRAMINGHAM.

For BMIs over 40, the risk is insurable as long as other cardiovascular and pulmonary risk factors are under control. Beyond a BMI of 50, the insurance approach is reserved.

Finally, patients who have undergone bariatric surgery will be able to be rated taking into account their current BMI and their pre-operative BMI, so long a sufficient time has passed since surgery and there are no complications.

Once again, SCOR has developed a calculator, available in its SOLEM rating tool, which automatically considers these parameters to arrive at an overall mortality rate.

CONCLUSION

From an epidemiological standpoint, obesity is an epidemic that is affecting almost all countries around the globe.

The definition is simple - "abnormal or excessive fat accumulation that presents a risk to health" - but the causes behind this sweeping change are complex and varied. There are genetic, environmental and hormonal factors to obesity which all interact in complicated ways that are not yet fully understood.

The consequences of obesity are also varied, ranging from metabolic, endocrine and cardiovascular repercussions to musculoskeletal, liver complications and even psychological impacts.

The increase in obesity rates and its associated excess mortality should be considered in terms of the pricing perspective. SCOR has adapted a pricing and underwriting approach that more precisely assesses the mortality risk associated with obesity, by integrating different cardiovascular risk factors into its evaluation.

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Publisher
Paolo De Martin

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SCOR
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