

10 Obesity

Burden, epidemiology and priority interventions

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The obesity epidemic is one of the biggest challenges facing society in the 21st century. In addition to multiple physical and mental health effects, obesity has considerable socio-economic impacts, as well as broader development implications, across a nexus that includes health and education, agriculture and industry, and climate action and the environment.¹ The fact that there is no chance of reaching the WHO Global NCD Action Plan target of a zero increase in rates of obesity and diabetes between 2010 and 2025 emphasizes that new bold approaches are required if the world is to tackle the issue of overweight and obesity.

Definition of overweight and obesity

Being overweight is a condition characterized by excessive adiposity, and obesity is defined as a chronic complex disease defined by excessive adiposity that can impair health. Obesity is in most cases a multifactorial disease due to obesogenic environments, psycho-social factors and genetic variants. In a subgroup of patients, single major etiological factors can be identified (diseases, immobilization, iatrogenic procedures, monogenic disease/genetic syndrome). Body mass index (BMI) is a surrogate marker of adiposity calculated as weight divided by height squared (kg/m^2). In adults, there are three levels of obesity severity in recognition of different management options, and the BMI categories for defining obesity vary by age and gender in infants, children and adolescents (Box 10.1).

BOX 10.1 DEFINITION OF OVERWEIGHT AND OBESITY IN ADULTS AND CHILDREN²

Adults

- Overweight: BMI ≥ 25
- Obesity: BMI ≥ 30
 - Obesity Class I: BMI 30.0–34.9
 - Obesity Class II: BMI 35.0–39.9
 - Obesity Class III: BMI ≥ 40

Children aged between 5 and 19 years

- Overweight: BMI-for-age >1 standard deviation (SD) above the WHO growth reference median.
- Obesity: BMI-for-age >2 SD above the WHO growth reference median.

Children under 5 years

- Overweight: weight-for-height or BMI-for-age >2 SD above the WHO child growth standards median.
- Obesity: weight-for-height or BMI-for-age >3 SD above the WHO child growth standards median.

International charts/tables for children aged 5–19 years and those <5 years are available from WHO and elsewhere.³ Some countries have developed charts/tables for their populations.

While BMI provides the most useful population-level measure of overweight and obesity as thresholds that do not depend on the sex and age in adults, it remains a fairly rough marker of adiposity in different individuals.⁴ BMI does not distinguish well between muscle and fat mass, and some individuals with a normal BMI can have increased adipose tissue and cardiometabolic risk, while some muscular individuals may have a high BMI with normal adipose tissue and no increased risk.

Waist circumference (or waist circumference ratio, Table 10.1) is also a useful measure of adiposity, particularly abdominal adipose tissue. Similar to BMI, it is a fairly good predictor of cardiometabolic risk (e.g. increased blood glucose, triglycerides, insulin resistance, and reduced HDL-cholesterol) and can be used on its own or in conjunction with BMI.⁵

Overall, both BMI and waist circumference (or waist-to-hip ratio) fall short of gold standards (such as dual-energy x-ray absorptiometry, MRI, or isotope dilution methods), with a correlation of around 0.8 for predicting adipose

Table 10.1 WHO cut-off points for waist circumference and waist-to-hip ratio and risk of metabolic complications in adults

<i>Indicator</i>	<i>Cut-off points (men/women)</i>	<i>Risk of metabolic complications</i>
Waist circumference	$>94/80$ cm	Increased
	$>102/88$ cm	Substantially increased
Waist-to-hip ratio	$\geq 0.90/0.85$	Substantially increased

Table 10.2 Mortality attributable to high BMI (IHME)

	<i>Global</i>		<i>HICs</i>		<i>UMICs</i>		<i>UMICs</i>		<i>LICs</i>	
	1990	2019	1990	2019	1990	2019	1990	2019	1990	2019
Number of deaths (million)	2.2	5.0	0.8	1.1	0.9	2.0	0.5	1.7	0.06	0.2
Proportion of all deaths (%)	4.7	8.9	9.5	10.4	5.9	10.4	2.5	7.9	1.4	3.8
Age-standardized mortality (per 100,000)	60	63	64	47	63	63	47	72	44	60

tissue but are adequate as screening tools for clinical and population use. Gold standards are clinically impractical and too costly for routine use.⁶

Disease burden

According to IHME, increased high BMI (≥ 25 kg/m²) accounted for 8.9% of all deaths (5 million) in 2019 globally, as compared to 2.2 million in 1990, as a result of a combination of the increasing prevalence of obesity and growth and aging of populations over time (Table 10.2). Mortality attributable to high BMI, in percent of all deaths, increased in all regions. Age-standardized mortality rates attributable to high BMI increased in most regions but decreased in high-income countries (HICs), possibly owing to better control of complications of obesity in HICs than in low- and middle-income countries. Mortality attributable to high BMI was as follows globally in 2019 (IHME): 64% was attributable to CVD, 20% to diabetes and 9% to cancer. Increased BMI accounted globally for 4.9% of years lived with an obesity-related disease, mainly attributable to diabetes (64%).

Prevalence of overweight and obesity^{7,8,9}

Around 2 billion adults were overweight in 2016, and 650 million of them had obesity (i.e. 39% and 13% of the world's population respectively). In 2016, over 340 million children and adolescents aged 5–19 were overweight or had obesity, and in 2020, 39 million children under the age of five years were overweight or had obesity. The worldwide prevalence of obesity nearly tripled between 1975 and 2016 in both adults and children.

Levels of overweight and/or obesity among adults are highest (up to 50–70%) in the Pacific and Caribbean islands, the Middle East, Mexico and the USA. In Africa, the number of overweight children under five years has increased by nearly 24% percent since 2000. While the prevalence of overweight/obesity was typically higher among wealthier vs poorer populations until a few decades ago (in part because food was less accessible to poorer vs

wealthier people), this has reversed in many countries (in part because of the increased availability of inexpensive energy-dense foods).

Health consequences of overweight and obesity

Increased BMI is associated with impairment of blood glucose and lipids levels, increased blood pressure, cardiovascular disease (CVD), many types of cancer (e.g. endometrial, oesophageal, stomach, liver and kidney, breast and colorectal) and premature mortality.^{10,11,12} Obesity is also associated with other conditions, including respiratory (e.g. obstructive sleep apnoea), gastrointestinal (e.g. non-alcoholic fatty liver disease, reflux oesophagitis), musculoskeletal (e.g. lower extremity malalignment, lower back pain, osteoarthritis), soft tissue (e.g. cellulitis), reproductive (e.g. early puberty, polycystic ovary syndrome) and greater likelihood of postoperative complications. No less are the psycho-social consequences, including weight stigma, discrimination, lower wages, lower quality of life and a likely susceptibility to depression. The combination of several cardio-metabolic indicators (increased BMI and/or waist circumference, blood glucose, triglycerides and blood pressure, and decreased HDL-cholesterol) is referred to as metabolic syndrome and is associated with an increased risk of CVD risk.¹³

Obesogenic environments

Most world populations now live in environments which promote weight gain and increased rates of obesity. Commercial, societal and cultural factors contribute to the development of obesogenic environments. Commercial factors include massive advertising and promotion of ultra-processed foods and sugar-sweetened beverages and the ubiquitous supply of and access to low cost high-energy processed foods that have high shelf durability and large profit margins.¹⁴ The loss of recreation spaces and walkable environments, as well as the ever-increasing use of motorized transport, and electric or electronic appliances have reduced opportunities for physical activity at work and home. In some societies, being overweight is perceived as a sign of wealth, good health and fertility. Home and work pressures also contribute to the obesogenic environment, with compensatory calorie intake, including through 'convenient', rapid and easy-to-prepare energy-dense meals largely based on processed foods.

The importance of neuroendocrine systems and genetics

Satiety and hunger are regulated through complex, tight regulatory loops that involve hormones and peptides released by the adipose tissue (leptin, etc.), stomach and intestine (ghrelin, glucagon-like peptide 1, etc.), pancreas (insulin, glucagon etc) and brain/hypothalamus (melanocortin system, dopamine, etc.) in response to energy balance. This complex neuroendocrine system tends to defend adipose accumulation by stimulating energy intake (hunger) over energy expenditure (including through adjusting resting basal metabolic rate).¹⁵

These effects are enhanced by processed, and particularly ultra-processed foods (that require little in the way of chewing before swallowing and then being rapidly absorbed by the intestine), which in part bypass appetite satiety regulatory loops and can result in food overconsumption.¹⁶ These physiological mechanisms favoured energy conservation and humans' survival for thousands of years, when food was scarce but, in current obesogenic environments, favour weight gain.¹⁷ Obesity is a trait influenced by the complex interplay between food processing, gut microbiota composition and function, genetic variants, metagenomics and the environment^{18,19} and patterns at the individual level may partly explain why some people are more prone than others to develop obesity.

Interventions at the population level

The multifactorial nature of obesity emphasizes the need for macro-policy interventions across multiple sectors to modify the obesogenic environments in order to prevent weight gain and increase the opportunity for people living with obesity to reduce weight.²⁰ A number of interventions are WHO best buys or recommended interventions (Box 10.2). Tackling the obesogenic environments also requires behavioural change at scale as well as whole-of-government action (e.g. legal, fiscal and regulatory policies to address commercial determinants of NCDs) and requires support from the private sector. These issues are considered in more detail in other chapters.

BOX 10.2 SUMMARY OF WHO BEST BUYS, EFFECTIVE INTERVENTIONS, OTHER RECOMMENDED INTERVENTIONS, AND ENABLING INTERVENTIONS THAT HAVE AN IMPACT ON OBESITY

Best buys

- Implement community-wide public education and awareness campaigns for physical activity.

Effective interventions

- Reduce sugar consumption through effective taxation on sugar-sweetened beverages.

Other recommended interventions

- Promote and support exclusive breastfeeding for the first six months of life.

- Implement subsidies to increase the intake of fruits and vegetables.
- Limit portion and package size.
- Implement nutrition education and counselling in preschools, schools, workplaces, hospitals etc. to increase the intake of fruits, vegetables and whole-grain foods.
- Implement nutrition labelling.
- Implement mass media campaigns on healthy diets, including social marketing to reduce the intake of total fat, saturated fats, free sugars and salt, and promote the intake of fruits, vegetables and whole-grain foods.
- Ensure that macro-level urban design addresses residential density, connected street networks including sidewalks, cycle lanes and access to public transport.
- Implement a whole-of-school programme that includes quality physical education and availability of adequate facilities and programmes.
- Provide convenient and safe access to quality public open space and adequate infrastructures to support walking and cycling.
- Implement multi-component workplace physical activity programmes.
- Promote physical activity through organized sports groups and clubs, programmes and events.

Enabling interventions

- Implement the WHO global strategy on diet, physical activity and health.
- Implement the WHO recommendations on the marketing of foods and non-alcoholic beverages to children.

Interventions at the individual level

The provision of equitable access to integrated healthcare services for the management of obesity should be part of universal health coverage. After a careful medical evaluation, people living with obesity should receive individualized care plans that address the causes and provide support for behavioural change (e.g. nutrition, eating behaviours, physical activity, sedentary behaviours) and adjunctive therapies, which may include psychological, pharmacologic and surgical interventions.²¹ Achieving maximum weight loss in the shortest possible time is *not* the key to successful treatment; evidence suggests that a 5–10% weight loss in adults is often sufficient to obtain substantial health benefits from decreasing obesity-related comorbidities. During childhood and adolescence, the aims of treatment are to slow down weight gain while ensuring normal growth, prevent premature complications and improve quality of life. More research is currently needed to shift the focus of obesity management toward focusing on health and psycho-social outcomes rather than weight alone.

Counselling on a healthy diet, including favouring drinking water over consumption of sweetened soft drinks,²² and regular physical activity should be included in routine primary health care services. While this can lead to significant weight loss (or weight control in youth) among some patients living with obesity, particularly if provided through specialist care and long follow-up, advice and counselling on healthy nutrition and physical activity results often in only modest weight changes.²³ Low-calorie diets can result in short-term weight loss, but a majority of individuals regain the weight that they have lost.²⁴ Chapters 19 on nutrition and Chapter 25 on physical activity describe healthy patterns and interventions.

Pharmacotherapy is usually recommended for weight loss and weight-loss maintenance for individuals with BMI ≥ 30 or BMI ≥ 27 with adiposity-related complications, to support behavioural and psychological interventions. A recent report suggests that compared to lifestyle alone (which reduced body weight by 3.4%), phentermine-topiramate, orlistat, or naltrexone-bupropion reduced body weight by an additional (3–8%) amount.²⁵ Newer medications acting on specific mechanisms of appetite regulation result in larger and more sustained weight reduction. For example, the GLP-1 agonist semaglutide reduced body weight by 12.7% (and also reduced blood sugar and CVD risk) in individuals with obesity.²⁶ Nausea and diarrhoea were the most common adverse events with semaglutide; they were typically transient and mild-to-moderate in severity and subsided with time. Other medications, which act on underlying adipocyte-gut-brain mechanisms, are being developed and may have even larger effects.²⁷

Bariatric surgery, including gastric banding, gastric bypass and sleeve gastrectomy, is increasingly used in adults and adolescents where resources are available. Surgery results in large weight loss²⁸ and induces improvement or even remission of obesity-related conditions such as hypertension and type-2 diabetes, and increases life expectancy.²⁹ Surgery can be cost-effective when set against the high costs of obesity to the individual and society.³⁰

Targets and indicators in the WHO Global NCD Action Plan

Target	To halt the rise in diabetes and obesity between 2010 and 2025. (Combining diabetes and obesity into one target emphasizes the strong relationship between the two that has been described in this chapter.)
Indicators	Age-standardized prevalence of overweight and obesity in persons aged 18+ years (BMI ≥ 25 for overweight and BMI ≥ 30 for obesity). Prevalence of overweight and obesity in adolescents (defined according to the WHO growth reference for children and adolescents).

Monitoring

Prevalence and trends of overweight and obesity, as well as physical activity and diet, can be assessed through population-based surveys in adults and children/adolescents (see Chapters 5, 19 and 25 on surveillance tools, diet and physical activity). It is also important to monitor health care for individuals with obesity.

Notes

- 1 Swinburn BA et al. The global syndemic of obesity, undernutrition, and climate change: the Lancet Commission report. *Lancet* 2019;393:791–846.
- 2 Key facts. Obesity and overweight. WHO, 2021.
- 3 Cole TJ et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240–3.
- 4 Adab P et al. Is BMI the best measure of obesity? It works for most people most of the time. *BMJ* 2018;360:k1274.
- 5 Waist circumference and waist-hip ratio report of a WHO expert consultation. WHO, 2008.
- 6 Batsis JA et al. Diagnostic accuracy of body mass index to identify obesity in older adults: NHANES 1999–2004. *Int J Obes* 2016;40:761–67.
- 7 NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *Lancet* 2016;387:1377–96.
- 8 NCD Risk Factor Collaboration. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet* 2017;390:2627–42.
- 9 Levels and trends in child malnutrition: UNICEF/WHO/The World Bank Group joint child malnutrition estimates: key findings of the 2021 edition. WHO, 2021.
- 10 Haslam DW, James PT. Obesity. *Lancet* 2005;366:1197–209.
- 11 Bhaskaran K et al. Association of BMI with overall and cause-specific mortality: a population-based cohort study of 3.6 million adults in the UK. *Lancet Diabetes Endocrinol* 2018;6:944–53.
- 12 Jayedi A et al. Central fatness and risk of all cause mortality: systematic review and dose response meta-analysis of 72 prospective cohort studies. *BMJ* 2020;370:m3324.
- 13 Ritchie SA, Connell JCM. The link between abdominal obesity, metabolic syndrome and cardiovascular disease. *Nutr Metab Cardiovasc Dis* 2007;17:319–26.
- 14 Popkin BM et al. Towards unified and impactful policies to reduce ultra-processed food consumption and promote healthier eating. *Lancet Diab Endocrinol* 2021;9:462–70.
- 15 Schwartz MW et al. Obesity pathogenesis: an endocrine society scientific statement. *Endocr Rev* 2017;38:267–96.
- 16 Koenen M et al. The high incidence of overweight/obesity is closely related to overconsumption of inexpensive and palatable high fat and high refined carbohydrate diets. *Circ Res* 2021;128:951–68.
- 17 Fildes A et al. Probability of an obese person attaining normal body weight: cohort study using electronic health records. *Am J Public Health* 2015;105:e54–9.
- 18 Loos RJJF et al. The genetics of obesity: from discovery to biology. *Nat Rev Genet* 2022;23:120–33.
- 19 Mozaffarian D. Obesity – an unexplained epidemic. *Am J Clin Nutr* 2022;115:1445–1450.
- 20 Report of the Commission on Ending Childhood Obesity. *Implementation plan: Executive summary*. WHO, 2017.
- 21 Schutz D et al. European practical and patient-centred guidelines for adult obesity management in primary care. *Obes Facts* 2019;12:40–66.
- 22 Lichtenstein AH et al. 2021 dietary guidance to improve cardiovascular death: a scientific statement from the American Heart Association. *Circulation* 2021;144:e472–87.
- 23 Weight management: lifestyle services for overweight or obese adults. National Institute for Health and Care Excellence, 2014.
- 24 Hartmann-Boyce J et al. Association between characteristics of behavioural weight loss programmes and weight change after programme end: systematic review and meta-analysis. *BMJ* 2021;374:n1840.

- 25 Shi Q et al. Pharmacotherapy for adults with overweight and obesity: a systematic review and network meta-analysis of randomised controlled trials. *Lancet* 2022;399:259–69.
- 26 Wilding J. et al. Once-weekly semaglutide in adults with overweight or obesity. *NEJM* 2021;384:989–1002.
- 27 Müller TD et al. Anti-obesity drug discovery: advances and challenges. *Nat Rev Drug Discov* 2022;21:201–23.
- 28 Adams TD et al. Weight and metabolic outcomes 12 years after gastric bypass. *NEJM* 2017;377:1143–55.
- 29 Syn NL et al. Association of metabolic–bariatric surgery with long-term survival in adults with and without diabetes: a one-stage meta-analysis of matched cohort and prospective controlled studies with 174’772 participants. *Lancet* 2021;397:1830–41.
- 30 Harrison S et al. Long-term cost-effectiveness of interventions for obesity: a Mendelian randomisation study. *PLoS Med* 2021;18:e1003725.