Prevention of Obesity in Europe – Consortium for the prevention of obesity through effective nutrition and physical activity actions – EURO-PREVOB

Tackling the social and economic determinants of nutrition and physical activity for the prevention of obesity across Europe

D3.1: Review of the literature of obesity (and inequalities in obesity) in Europe and of its main determinants: nutrition and physical activity

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EURO-PREVOB

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Abstract

Excess body weight is one of the most serious threats to the future health of the citizens of Europe. Within the context of the EURO-PREVOB project, workpackage 3 (WP3) aimed to provide a comprehensive background review of the scientific and policy evidence required for the development of the next phases of the project and to adequately respond to the multifaceted nature of obesity and its multiple, complex, and often inter-related risk factors. WP3 thus entailed the preparation of two literature reviews at the European level. The present document constitutes the first review, which aims to provide a comprehensive understanding of scientific knowledge on variations and trends in obesity prevalence, in the health and economic burden of obesity, and in socioeconomic inequalities in obesity in Europe; and on nutrition and physical activity as determinants of obesity and inequalities in obesity in Europe.

List of abbreviations

The following abbreviations are used in this report:

BMI	Body mass index
D	Deliverable
DALY	Disability-adjusted life years
EC	European Commission
EU	European Union
EURO-PREVOB	Prevention of Obesity in Europe – Consortium for the prevention of obesity through effective nutrition and physical activity actions
GDP	Gross domestic product
GNP	Gross national product
IDF	International Diabetes Federation
WHO	World Health Organization
MONICA	Multinational **MONI**toring of trends and determinants in **CA**rdiovascular disease
PPP	Purchasing power parity
WP	Workpackage

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1. Introduction

Excess body weight is one of the most serious threats to the future health of the citizens of Europe. Overweight already affects up to 80% of adults and 20% of children and adolescents in the Region, and the prevalence of obesity is rising at an alarming rate, with 150 million adults and 15 million children expected to be obese by 2010 [1]. The high rates justify the high priority that obesity and its main determinants – inadequate nutrition and physical activity – have been given in EU health policies and action programmes but there is still much to be done, in terms of coordination of scientific, regulatory and policy issues, and in the provision of enhanced information.

Within the context of the EURO-PREVOB project, WP3 aimed to provide a comprehensive background review of the scientific and policy evidence required for the development of the next phases of the project and to adequately respond to the multifaceted nature of obesity and its multiple, complex, and often inter-related risk factors. WP3 thus entailed the preparation of two literature reviews at the European level.

The aims of the reviews of the literature are:

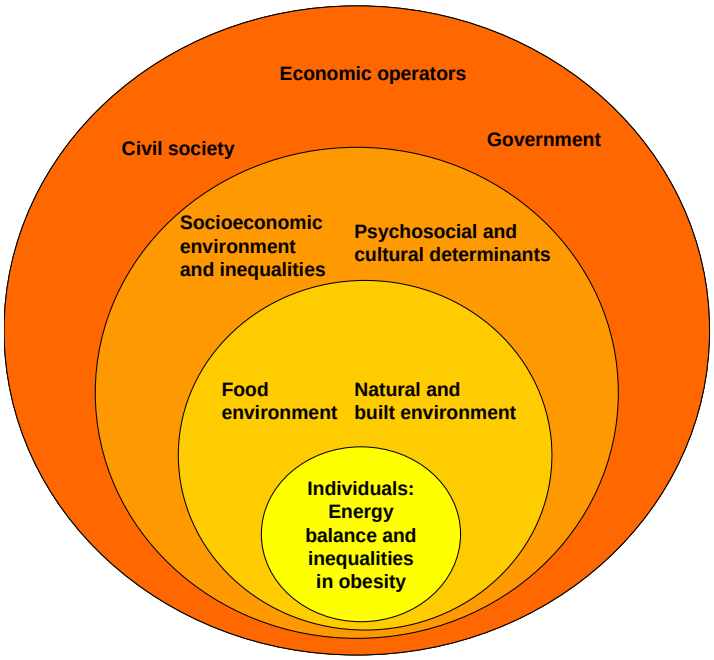
1. Review 1: to provide a comprehensive understanding of scientific knowledge on variations and trends in obesity prevalence, in the health and economic burden of obesity, and in socioeconomic inequalities in obesity in Europe; and on nutrition and physical activity as determinants of obesity and socioeconomic inequalities in obesity in Europe;
2. Review 2: to enhance the understanding of the existing public health policy situation with regard to nutrition and physical activity as determinants of obesity and socioeconomic inequalities in obesity in the EU and the wider European level.

The third deliverable of EURO-PREVOB (D3) is divided into two main parts (D3.1 and D3.2), each corresponding to one of the reviews of the literature described above. The present document constitutes D3.1. Using a life-course approach and taking into account the EURO-PREVOB Conceptual Framework described below, the objective of D3.1 is to summarise key findings on the prevalence, patterns and trends in obesity and socioeconomic inequalities in obesity, and on the determinants of obesity and socioeconomic inequalities in obesity.

Conceptual framework

A conceptual model has been developed (Figure 1) to guide the work of EURO-PREVOB, to provide a logical framework for assessing the selected policy areas, and specifically to help develop the policy analysis tool described below. The model draws upon findings of the recent Foresight project [2] and other conceptual models for the study of environmental indicators of obesity [3]. The work developed in the second review of WP3 [4] sets out a rationale for best assessing the response to and implementation of the selected policy areas, which is reflected in the conceptual framework: Individuals (and their intrinsic risk of obesity) live in a particular context formed by the food environment and the natural and built environment (which affects physical activity), both interacting in various instances such as in schools. These environments are influenced by a broader, cross-cutting context, the socioeconomic environment and inequalities, and psychosocial and cultural determinants. Governments, economic operators and civil society have significant influence on these environments and determinants.

Figure 1. EURO-PREVOB conceptual framework



2. Methods

The methods used to identify existing reviews of the literature and the latest key scientific articles are described below.

Search strategy and retrieval results

Three key primary studies have recently been commissioned by European agencies and organisations such as the European Commission, the World Health Organization (WHO) Regional Office for Europe and individual European governments, to provide the scientific background for how countries can best respond to the obesity epidemic affecting Europe. In light of the mandate of this workpackage, it was decided to base our work on these reports, starting from the premise that the core findings have already been reviewed and documented. These primary studies are described in Table 1.

This information was updated by a targeted search of the literature on the following topics, as outlined in the project contract:

- variations and trends in obesity prevalence
- the health and economic burden of obesity
- socioeconomic inequalities in obesity
- nutrition and physical activity as determinants of obesity and socioeconomic inequalities in obesity.

The Cochrane Library and PUBMED database were searched for published articles during the period between 1 January 2007 and 21 December 2007. The text terms used in the search included [(("Obesity/complications"[Mesh] OR "Obesity/economics"[Mesh] OR "Obesity/epidemiology"[Mesh] OR "Obesity/etiology"[Mesh] OR "Obesity/genetics"[Mesh] OR "Obesity/prevention and control"[Mesh] OR "Obesity/statistics and numerical data"[Mesh]) OR ("Overweight/complications"[Mesh] OR "Overweight/epidemiology"[Mesh] OR "Overweight/etiology"[Mesh] OR "Overweight/genetics"[Mesh] OR "Overweight/prevention and control"[Mesh])) AND (inequal* OR poverty OR socioeconomic OR econom* OR cost* OR burden* OR nutriti* OR sedentar* OR physical activity OR physical inactivity OR transport* OR diet*)]; limited to human studies and not animals; English language; AND reviews.

Articles were rejected on initial screening if it was possible to determine from the title and abstract that the article was not a review of the literature on excess body weight in Europe, or if any of the following exclusion criteria were met: 1) the review did not address excess body weight specifically; 2) the review was not on humans; 3) the review was on individuals with specific illnesses; 4) the review addressed interventions on and treatments of obesity; 5) the review was on policy implications of obesity; and 6) the review addressed specifically a non-European country. When a paper could not be rejected with certainty from the inspection of the title and abstract, the full text was obtained for further evaluation.

A total of 298 records were identified, of which 51 papers were selected as relevant to WP3 D3.1 (Table 2). Selected recent additional reviews and key papers considered important to the review objectives were also included.

As much previous research has been undertaken or has been reported within the framework of activities by the World Health Organization (WHO), the term “Europe” is used to mean the 53 countries of the WHO European Region except where otherwise specified.

Presentation of findings

The key findings of the reports considered here are presented mainly in table format with a brief accompanying explanatory text. The presentation of the review findings is guided by the conceptual framework chosen for the EURO-PREVOB project (Figure 1).

Table 1. Key primary studies

Authors, year and reference	**Title**	**Type of review**	**Population covered**	**Main subject areas covered**	**Commissioned by**	**Considered socioeconomic inequalities**
Robertson et al., in press [5]	Obesity and socio-economic groups in Europe: Evidence review and implications for action	Academic	Europe	Inequalities in obesity: inequalities in prevalence, determinants, policy options	European Commission – DG SANCO	Yes
Branca et al., 2007 [1]	The challenge of obesity in the European Region and the strategies for response	Academic	WHO European Region	Excess body weight: prevalence, determinants, impacts, policy options	WHO (background for 2006 WHO Ministerial Conference on Counteracting Obesity)	Yes
Butland et al., 2007 [2]	Foresight - Tackling obesities: future choices – project report	Academic	UK	Excess body weight: prevalence, determinants, impacts, policy options	UK Government Office for Science	Yes

Table 2. Reviews identified through the literature search

Authors, year and reference	Title	Population covered	Main subject areas covered	Considered socioeconomic inequalities
Aggoun, 2007 [6]	Obesity, metabolic syndrome, and cardiovascular disease.	World	Link between obesity, the metabolic syndrome, cardiovascular function, and prevention	No
Allender & Rayner, 2007 [7]	The burden of overweight and obesity-related ill health in the UK.	UK	Economic and health costs of obesity in the UK	No
Barker, 2007 [8]	Obesity and early life.	World	Link between early growth and later disease, prevention of childhood obesity and later disease	No
Benyshek, 2007 [9]	The developmental origins of obesity and related health disorders--prenatal and perinatal factors.	World	Developmental pathways to obesity, with an anthropological perspective	Yes
Canoy & Buchan, 2007 [10]	Challenges in obesity epidemiology.	Mainly UK	Prevalence and determinants of obesity, health impacts, research needs	Yes
Chiolero et al., 2007 [11]	Has blood pressure increased in children in response to the obesity epidemic?	World	Trends in blood pressure and elevated blood pressure in children	No
Clark et al. 2007 [12]	How do parents' child-feeding behaviours influence child weight? Implications for childhood obesity policy.	Mainly UK	Possible consequences on child weight gain of inadequate child-feeding behaviours by parents	No
Dennis 2007 [13]	Postmenopausal women and the health consequences of obesity.	Generally directed towards USA	Health impacts of obesity- the effects of obesity that have particular relevance for postmenopausal women	No
Department of Health et al., 2007 [14]	Obesity and health inequalities.	UK	The life course and ecological approaches to inequalities in obesity	Yes
De Silva et al., 2007 [15]	Obesity in the adolescent female.	Generally directed towards USA	Definition, aetiology, co-morbidities and treatment of obesity in adolescent females	No
Drewnowski, 2007 [16]	The real contribution of added sugars and fats to obesity.	Generally directed towards USA	Examining past studies of the contribution of added sugars and fats to obesity rates through the prism of food prices and diet costs	Yes
Durand et al., 2007 [17]	Association of maternal obesity and childhood obesity: implications for healthcare providers.	Generally directed towards USA	The generational cycle of obesity and implications for health professionals, e.g. community health nurses	No
Ferreira et al., 2007 [18]	Environmental correlates of physical activity in youth – a review and update.	World	Obesogenic environments and physical activity	No
Forshee et al., 2007 [19]	A critical examination of the evidence relating high fructose corn syrup and weight gain.	USA	Review of the literature on HFCS and obesity	No

Authors, year and reference	Title	Population covered	Main subject areas covered	Considered socioeconomic inequalities
Francischetti & Genelhu, 2007 [20]	Obesity-hypertension: an ongoing pandemic.	World	Excessive weight gain and arterial hypertension	No
Gaesser, 2007 [21]	Carbohydrate quantity and quality in relation to body mass index.	Focus on USA	Review of the literature on carbohydrates and obesity	No
Giovannucci & Michaud, 2007 [22]	The role of obesity and related metabolic disturbances in cancers of the colon, prostate, and pancreas.	World	Major metabolic consequences of excess energy consumption/obesity and influence on cancer of the colon, prostate and pancreas	No
Hills et al., 2007 [23]	The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: implications for overweight and obesity.	World	Physical in/activity from early childhood to adolescence and impact on weight gain	No
Jebb, 2007 [24]	Dietary determinants of obesity.	World	Review of dietary determinants of obesity including fat, carbohydrate, fibre, protein, other specific foods, dietary patterns	No
Jeffery & Harnack, 2007 [25]	Evidence implicating eating as a primary driver for the obesity epidemic.	Focus on USA	Review of data implicating increased energy intake as the cause of rising body weight	Yes
Kelishadi, 2007 [26]	Childhood overweight, obesity, and the metabolic syndrome in developing countries.	World (selection of less developed countries)	Prevalence of excess body weight and of metabolic syndrome in boys and girls	Yes
Klein et al., 2007 [27]	Waist circumference and cardiometabolic risk: a consensus statement from shaping America's health.	World	Measurement technique, biological mechanisms responsible for the association of waist circumference with cardiometabolic risk, predictive power, clinical usefulness	No
Kopelman, 2007 [28]	Health risks associated with overweight and obesity.	World	Risks, metabolic changes and diseases associated with excess body weight, potential interventions, research needs	No
Kosti & Panagiotakos, 2006 [29]	The epidemic of obesity in children and adolescents in the world.	World	Determinants and health impact of childhood obesity and interventions	Yes
Larsen et al., 2007 [30]	Sexual function and obesity.	World	Relationship between obesity and sexual dysfunction	No
Maffeis & Castellani, 2007 [31]	Physical activity: an effective way to control weight in children?	World	Metabolic effects of physical activity, available evidence on physical activity programs to prevent childhood obesity	Yes

Authors, year and reference	Title	Population covered	Main subject areas covered	Considered socioeconomic inequalities
Maibach, 2007 [32]	The influence of the media environment on physical activity: looking for the big picture.	USA	Opportunities to influence the media environment for the purposes of promoting physical activity	No
Mathus-Vliegen et al., 2007 [33]	Oral aspects of obesity.	World	Obesity pathogenesis/ consequences/ treatment, oral health (e.g. caries, periodontitis, xerostomia), impact of obesity on oral treatment	Yes
McCormick & Stone, 2007 [34]	Economic cost of obesity and the case for government intervention	UK	Cost of obesity, rationale for government interventions and types of interventions	No
McLaren, 2007 [35]	Socioeconomic status and obesity.	World	Variations in obesity by development level and markers of socioeconomic status	Yes
Misra & Ganda, 2007 [36]	Migration and its impact on adiposity and type 2 diabetes.	World	Role of environmental factors in obesity and type 2 diabetes examined through the process of migration	Yes
Moreno & Rodríguez, 2007 [37]	Dietary risk factors for development of childhood obesity.	World	Review of evidence-based dietary aspects influencing obesity development in children and adolescents	Yes
Newby, 2007 [38]	Are dietary intakes and eating behaviors related to childhood obesity? A comprehensive review of the evidence.	World	Trends in dietary intake, dietary composition/patterns/behaviours, research needs, dietary advice, ethical considerations	Yes
Papas et al., 2007 [39]	The built environment and obesity.	World	Review of empirical research relating the built environment to obesity	Yes
Prentice, 2007 [40]	Are defects in energy expenditure involved in the causation of obesity?	World	Abnormalities in basal metabolic rate and thermogenesis, and treatment	No
Roblin, 2007 [41]	Childhood obesity: food, nutrient, and eating-habit trends and influences.	General but focus on Canada	Obesity trends, causes, influences, initiatives, food marketing	No
Runge, 2007 [42]	Economic consequences of the obese.	World but focus on USA	Economic costs of obesity at the individual level, in the workplace, and for governments	Yes
Ryan, 2007 [43]	Breastfeeding and the risk of childhood obesity.	World but focus on USA	Evidence for a link between breastfeeding and childhood overweight/obesity	Yes
Savage et al., 2007 [44]	Parental influence on eating behavior: conception to adolescence.	USA	Role of parents in diet during transition period from an exclusive milk diet to a modified adult diet	No
Schor & Ford, 2007 [45]	From tastes great to cool: children's food marketing and the rise of the symbolic.	World but focus on USA	Children's food advertising, its effectiveness and impact, and current debates	No

Authors, year and reference	Title	Population covered	Main subject areas covered	Considered socioeconomic inequalities
Singhal, 2007 [46]	Does breastfeeding protect from growth acceleration and later obesity?	World	Role of early growth and breastfeeding in the development of obesity	Yes
Snethen et al., 2007 [47]	Childhood obesity: the infancy connection.	World	Factors in pregnancy, infancy and early childhood that influence childhood obesity risk	No
Tanumihardjo et al., 2007 [48]	Poverty, obesity, and malnutrition: an international perspective recogniszing the paradox.	World	The interrelationships between food insecurity, hunger, malnutrition and overnutrition	Yes
Torrance et al., 2007 [49]	Overweight, physical activity and high blood pressure in children: a review of the literature.	World	Negative influence of obesity on blood pressure and its determinants in children	No
Velasquez & Bhathena, 2007 [50]	Role of dietary soy protein in obesity.	USA	Literature on potential role of soy protein and its isoflavones in obesity	No
Vickers et al., 2007 [51]	Is later obesity programmed in utero?	World	Developmental programming of obesity	No
Viswanath & Bond, 2007 [52]	Social determinants and nutrition: reflections on the role of communication.	World but some focus on USA	How social determinants may mediate public health communication on diet and nutrition	Yes
Wareham, 2007 [53]	Physical activity and obesity prevention.	World	Physical activity in the primary prevention of weight gain and obesity, and key uncertainties	No
Wells et al., 2007 [54]	Programming of body composition by early growth and nutrition.	World	Fetal/postnatal growth and body composition, influence of nutrition, metabolic syndrome	No
Wendel-Vos et al., 2007 [55]	Potential environmental determinants of physical activity in adults: a systematic review.	World	Determinants of various types and intensities of physical activity among adult	Yes
White, 2007 [56]	Food access and obesity.	World but focus on UK	Food retail access, cost of a healthy diet, impact on dietary intake and link with obesity, research needs	Yes

Definitions used in the review

Overweight and obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health [57]. Various methods are used to determine if someone is overweight or obese. The most common methods are based on the relation between height and weight; others are based on the measurement of body fat. The most widespread indicator today is body mass index (BMI), calculated by dividing a person's weight in kilograms by height in metres squared. BMI is by far the most widely used measure in anthropometric surveys of obesity and thus in main databases, even though it only provides an approximation of adiposity and may not correspond to the same degree of fatness between individuals.

The World Health Organization uses overweight and obesity ranges in adults based on BMI. The use of the BMI is based on two main reasons: first, on a group basis, the BMI was shown to be reasonably correlated with body fat content; second, in a number of studies, a (J- or U-shaped) relationship was demonstrated between BMI and risk of mortality (all causes or cardiovascular), then based on this type of relationship, current BMI cut-offs were defined, as shown in Table 3.

In adult males and females, obesity thus corresponds to a BMI of 30 kg/m^2 or more and overweight, depending on how it is specified, corresponds to 1) a BMI of 25 kg/m^2 or more, or a BMI 25–29.99 kg/m^2 (i.e. between 25 and the cut-off for obesity). Most European countries now follow the World Health Organization definitions.

Table 3. Categories of adiposity in adults according to BMI.

Description	BMI (kg/m^2)
Underweight	under 18.5
Normal range	18.5–24.99
Overweight	25 or more
Obese	30 or more

Source: adapted from World Health Organization [58].

In children, measuring overweight and obesity is more challenging; the BMI classifications described in Table 3 are not appropriate as a measure of excess weight because they do not take account of normal differences in body fat between boys and girls and variations in body fat associated with normal growth patterns. In children, obesity is defined based on growth curves that describe, by sex, the evolution of BMI according to age [59]. Based on a standard BMI-for-age chart, an international definition of childhood obesity has been recommended by the International Obesity Task Force (IOTF). The definition relies on the centile curves that pass through the cut-off points of BMI 25 and 30 kg/m^2 used to define overweight and obesity in adults. National BMI-for-age charts are also available in many countries.

Other indicators such as waist circumference are used to define obesity in terms of body fat distribution. Waist circumference, and alternative measures such as the waist:hip circumference ratio, identify individual adults at increased risk of obesity-related cardiometabolic disease that are not captured by measurement of BMI [27]. Cut-off points for waist circumference in adults have been defined by the US National Heart, Lung, and Blood Institute [60] and the International Diabetes Federation (IDF) [61] primarily for clinical practice but also for health surveillance and

epidemiological research. Within its definition of the metabolic syndrome (defined as a cluster of conditions that increase the risk of developing vascular disease, including abdominal obesity, high blood pressure, high triglycerides, low HDL and glucose intolerance [62], the IDF defines ethnicity-specific cut-off points for central obesity. For Europeans, the cut-off points for high waist circumference in men and women are 102 and 88 cm respectively according to the US National Heart, Lung and Blood Institute guidelines, but 94 and 80 cm according to the IDF. Population-based survey data are sparse compared with those reporting BMI figures, and are not included in this review.

Socioeconomic inequalities in obesity

In this review, socioeconomic inequalities in obesity are defined as differences in the prevalence of obesity across higher and lower socioeconomic status groups [63]. Such differences may be manifest as a trend, with increasing prevalence from high to low status or vice versa, or as an uneven distribution. Typically, an inverse association (lower socioeconomic status – higher obesity) is seen in rich countries. A recent European study which examined inequalities in obesity (data were available for Finland, Sweden, Norway, Denmark, United Kingdom, Ireland, England, the Netherlands, Belgium, Germany, France, Italy, Portugal, Slovenia, Hungary, Czech Republic, Lithuania, Latvia, Estonia) reported that education-related inequalities in obesity (those with the lower education showing a higher prevalence of obesity) were particularly large in Southern Europe, but lower than average in eastern and the Baltic regions [64]. A positive association is often seen in developing countries [221], where food poverty is linked to undernutrition. As countries industrialise, this tends to reverse. These patterns are strong evidence that the prevalence and distribution of obesity is strongly influenced by social, economic and cultural factors.

Socioeconomic status can be measured in a variety of ways [65, 66]. Studies and surveys have often based their classification on education, occupation or income or a combination of these variables. Social classifications are becoming more sophisticated, recognising that other dimensions of experience, such as discrimination (racism), living and working conditions and social networks, are important in defining an individual's social position. These factors are strong influences on risk of obesity, through their impact on attitudes and behaviours towards health, body shape, diet and physical activity. In addition, it is important to recognise the potential negative consequences of obesity in the form of stigmatisation.

Disadvantaged populations

Disadvantaged populations are defined as those living in sub-optimal environments and suffering from inequalities as measured by income, education and occupation as well as marginalised populations including homeless people, refugee populations, ethnic minorities, and people suffering from mental ill health [5]. Poverty is a key determinant of ill health and its determinants, such as obesity [67], whether defined in absolute or relative terms (i.e. using a set standard which is the same in all countries and which does not change over time vs. in terms of the society in which an individual lives and which therefore differs between countries and over time) [68], and whether measured by income, socioeconomic status, living conditions, educational level or other indicators.

3. Epidemiology of obesity in Europe

This section summarises current evidence on variations and trends in adult and child obesity prevalence levels in Europe, and in the health and economic burden attributable to obesity. Differences according to indicators of socioeconomic inequalities are also described.

Prevalence and trends in overweight and obesity

Current data on the prevalence of excess body weight in Europe come from surveys of national and subnational samples collected by a range of institutions as part of government, academic institutions and non-governmental organisations' health survey activities. These data are collated primarily by OTF and WHO. Unfortunately, few European countries have conducted nationally representative surveys of their population covering all ages, let alone a sustained sequence of surveys that could explore secular trends in prevalence of excess body weight. In addition, several countries gather information on self-reported rather than measured height and weight, which is known to impact on the validity of prevalence figures (usually by underestimating the true prevalence of obesity) [69]. Furthermore, the comparability of prevalence estimates among studies is hampered by differences in sampling procedures, response rates, age ranges, data collection methods, years of data collection, and definitions of overweight and obesity or of socioeconomic status. It is thus important to keep these limitations in mind when examining the prevalence estimates and trends in overweight and obesity in Europe described below.

Current prevalence

Several recent reviews of the literature have summarised the evidence available and an outline of the main findings is provided in Table 4. Current observations suggest that overweight and obesity are major health problems in all European countries that can provide data, but with important differences in prevalence rates among countries in the Region.

Table 4. Findings on current prevalence of excess body weight in Europe, over the life course.

Evidence / Life course	Prevalence of excess body weight in Europe
Women of child-bearing age	Significant numbers of underweight young women have been reported in some countries including Hungary and Poland [70, 71]. As described below, the consequences of underweight in young women are serious for the health of these women and for the health of their offspring. The prevalence of obesity in child-bearing age has increased in Europe (see comments related to adults). Excess weight during pregnancy has been found to be a predictor of long-term obesity [72, 73, 74]; and that women who are overweight before pregnancy are most vulnerable to excessive gestational weight gain.
Infants and young children	Based on data available, the highest prevalence of overweight in children aged 0-5 years is observed in Ukraine (boys: 27.8%; girls: 27.3%) and Bosnia Herzegovina (boys: 17.1%; girls: 16.7%) [75].

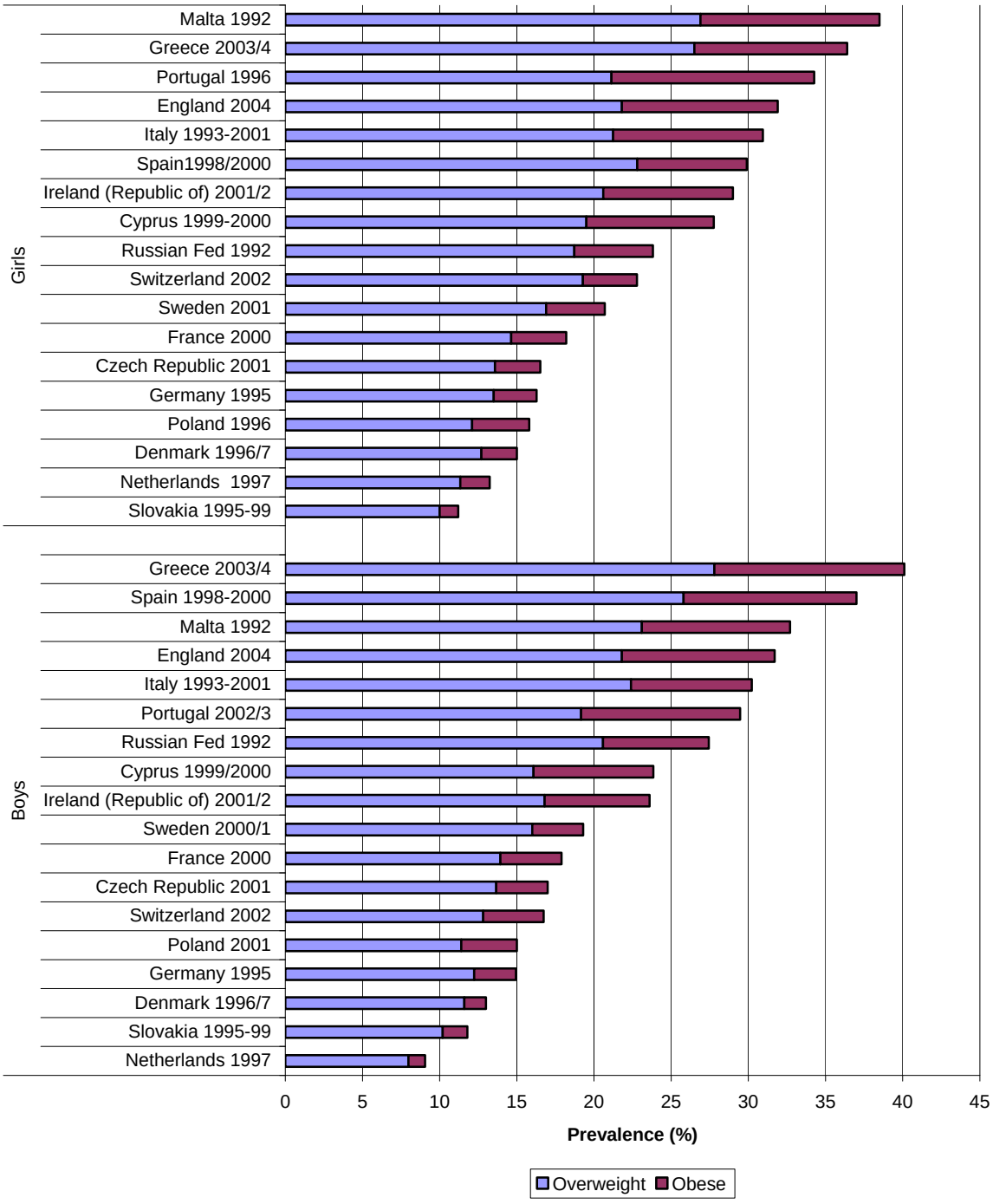
Evidence / Life course	Prevalence of excess body weight in Europe
Children and adolescents	Overall, about 20% of children in the European Region are overweight and a third of these are obese [1]. According to a review by Jackson-Leach and Lobstein, the prevalence of overweight among school-aged children can reach 35% in some parts of Europe [76]. Self-reported data from the Health Behaviour in School-aged Children (HBSC) study suggest that up to 9% boys and 5% girls aged 13 and 15 years are obese [75, 77]. Further prevalence statistics based on IOTF data are described below (see also Figures 1 and 2). In the EU-25, about 22 million children were either overweight or obese and 5 million were obese in 2006 [76]. It has been suggested that more than 60% of children who are overweight before puberty will be overweight in early adulthood [78].
Adults	Based on available data, the WHO estimates that about 30-80% of adults in the WHO European Region are overweight (32-79% men and 28-78% women) [75]; variations in the prevalence of obesity among European countries range from about 5-23% in men and 7-36% in women. Further prevalence statistics based on IOTF data are described below (see also Figures 3-4). The prevalence of overweight and obesity generally increases through adulthood, with highest prevalence being found among adults in their 50s and 60s [5]. Gender differences are not uniform across different age groups or groups differing by ethnicity, and patterns may appear paradoxical (e.g. in England women show consistently higher levels of obesity than men, but significantly lower levels of overweight in most age groups) [5].
Older people	Members of older age groups may, based on data available, show reduced overweight and obesity prevalence levels; this could be attributable to a healthier lifestyle during their younger years and/or to a selective attrition due to higher mortality rates from obesity-related diseases [5].

Using available data from the IOTF database, the prevalence of overweight (including overweight and obese children) in children aged approximately 7–11 years in selected countries of the WHO European Region ranges from 9 to 40% in boys and from 11 to almost 39% in girls (Figure 2). Obesity prevalence varies between 1 and 12%. The highest rates of prevalence of overweight and obesity are found in southern European countries (Malta, Greece, Portugal, Spain, Italy), as well as England. Children from northern countries (the Netherlands, Denmark, and Germany), in contrast, are estimated to be relatively slimmer, along with Slovakia and Poland.

In surveys of adolescents aged approximately 14–17 years from 19 European countries (Figure 3), males are generally more likely to present an excess body weight than their female counterparts; between 8 and 30% of boys and between 4 and 26% of girls are overweight (including the overweight and obese). A prevalence of overweight greater than 25% is observed in English adolescent males and females, and in males from three southern European countries, that is, Cyprus, Spain and Malta. The prevalence of obesity in the selected countries varies between about 1 and 11%, with the highest prevalence being observed in English adolescent girls (11%) and boys from Malta, Spain and England (9%).

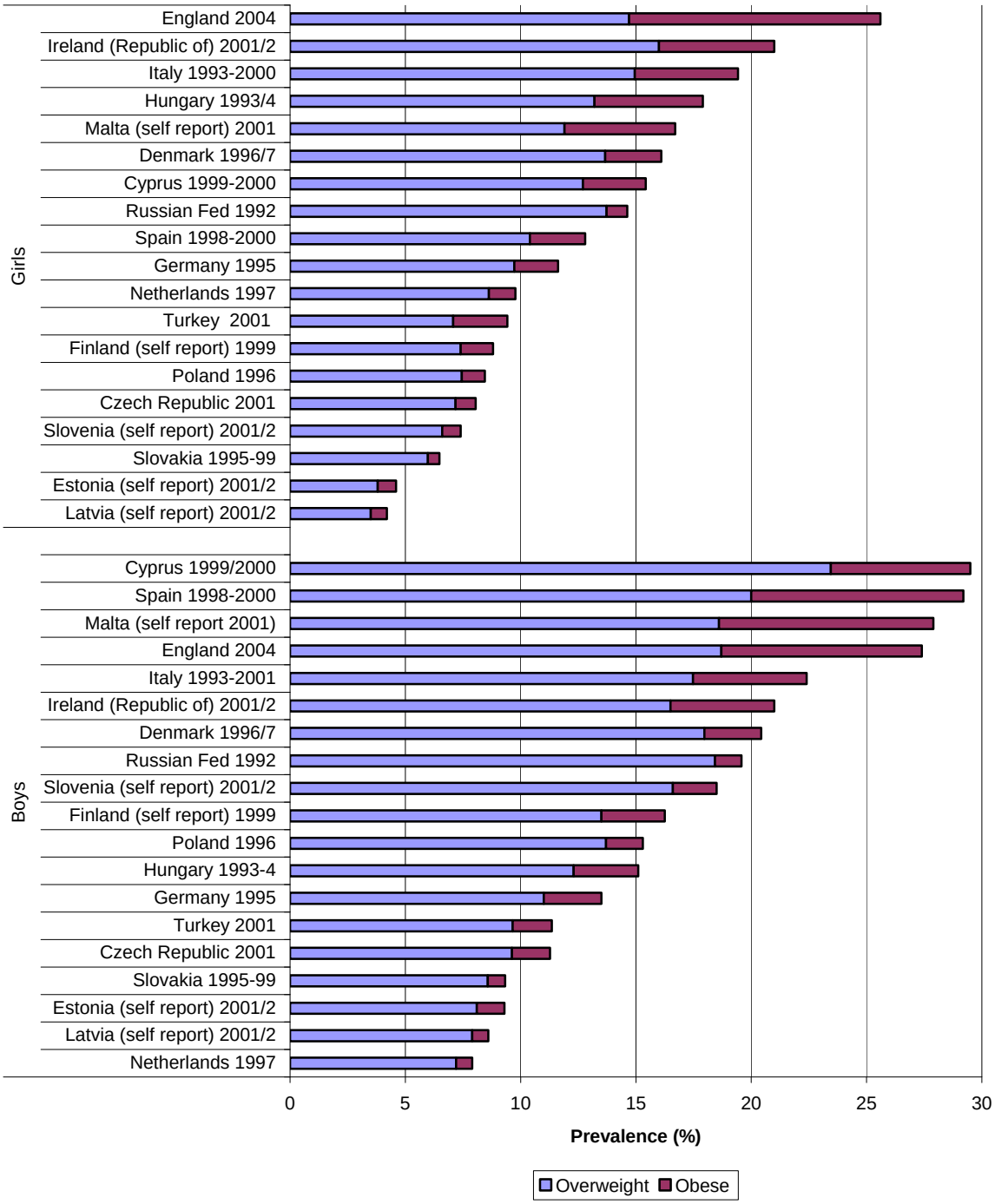
In adults, the prevalence of excess body weight is alarmingly high, with, in some countries, over three-quarters of the population examined being affected (Figures 4 and 5). The prevalence of overweight (BMI $\geq$25 kg/m^2) tends to be slightly higher in males (variations from 31% in Kyrgyzstan to 79% in urban Albania, in Croatia or Slovakia) than in females (variations from 23% in Kazakhstan to 84% in Slovakia). Obesity prevalence varies about eightfold among countries in males (from about 4% in Kyrgyzstan to 31% in Croatia) and about fivefold in females (from 7% in Armenia to 36% in Albania).

Figure 2. Prevalence of overweight and obese children aged 7–11 years in selected countries of the WHO European Region.



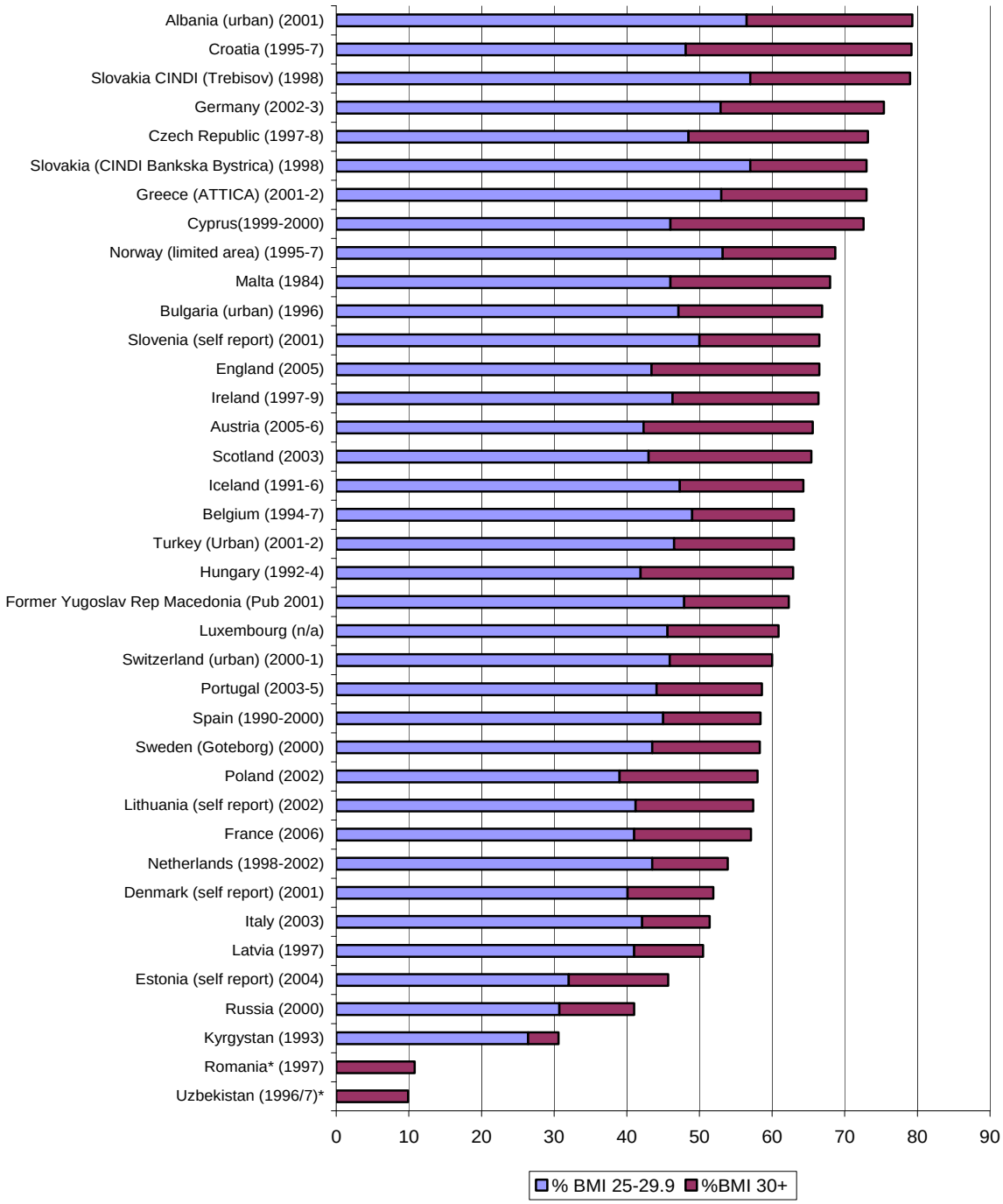
Source: International Obesity TaskForce [79]. Notes: This figure is based on data using IOTF cut-off points to define overweight and obesity. Age ranges from about 7 to 11 years. The data provided are limited by data availability. Not all the above figures are based on nationally representative studies. Sources and references for the different surveys are available from the IOTF database (http://www.iotf.org/database/index.asp, last visited 21 January 2008).

Figure 3. Prevalence of overweight and obese children aged 14–17 years in selected countries of the WHO European Region.



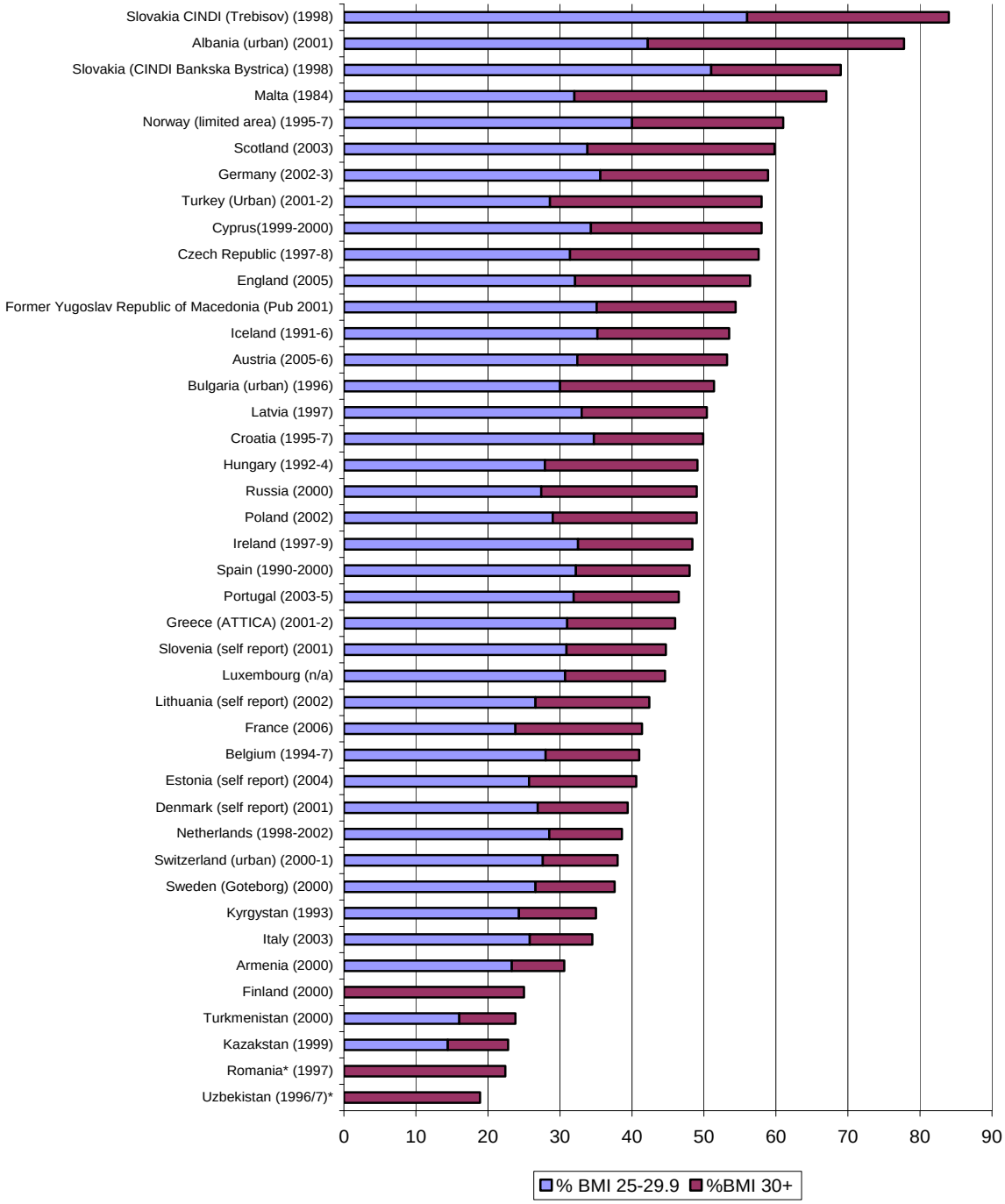
Source: International Obesity TaskForce [79]. Notes: This figure is based on data using IOTF cut-off points to define overweight and obesity. Age ranges from about 14 to 17 years. The data provided are limited by data availability. Not all the above figures are based on nationally representative studies. Sources and references for the different surveys are available from the IOTF database (http://www.iotf.org/database/index.asp, last visited 21 January 2008).

Figure 4. Prevalence of overweight and obese men in selected countries of the WHO European Region.



Source: International Obesity TaskForce [79]. Notes: (*) IOTF estimate. The data provided are limited by data availability. Date next to country signifies the year(s) of data collection. With the limited data available, prevalence figures are not age standardised. Self reported surveys may underestimate true prevalence. Population sample size varies according to country, as do age groups. Sources and references for the different surveys are available from the IOTF database (http://www.iotf.org/database/index.asp, last visited 21 January 2008).

Figure 5. Prevalence of overweight and obese women in selected countries of the WHO European region



Source: International Obesity TaskForce database [79]. Notes: (*) IOTF estimate. The data provided are limited by data availability. Date next to country signifies the year(s) of data collection. With the limited data available, prevalence figures are not age standardised. Self reported surveys may underestimate true prevalence. Population sample size varies according to country, as do age groups. Sources and references for the different surveys are available from the IOTF database (http://www.iotf.org/database/index.asp, last visited 21 January 2008).

Variations over time

Data available suggest that levels of excess body weight have increased at an alarming rate in children and adults in virtually all European populations during the last decades, with exceptions being found in some countries of eastern Europe during severe economic recessions [1, 3, 76, 80]. Overall, the prevalence of obesity has risen threefold or more since the 1980s, with increases being observed even in countries with traditionally low rates such as France, The Netherlands and Denmark [1, 79]. An outline of findings on secular trends in the prevalence of excess body weight in Europe is provided in Table 5. It is important to note that trend analyses are limited by the fact that they are based on the comparison of surveys that may not be entirely comparable (e.g. sometimes examining different populations and age groups).

Table 5. Findings on secular trends for the prevalence of excess body weight in Europe, along the life course.

Evidence / Life course	Secular trends for the prevalence of excess body weight in Europe
Women of child-bearing age	A Swedish study reported an increase in the prevalence of maternal pre-pregnancy overweight from 25% to 36% between 1992 and 2001; this rise was associated with an increase in large-for-gestational-age births [81].
Infants and young children	The number of low birth weight children appears to have decreased, while birth weight has increased in some European countries during the last decades (e.g. Denmark) [1]. Swedish data suggest an increase in the proportion of babies with a birth weight ≥4500 g between 1973 and 2004 (from 2.8% to 4.1%) [82], and in the proportion of large-for-gestational-age births between 1992 and 2001 (23% increase) [81].
Children and adolescents	Recent increases in obesity are particularly high in this age group in the WHO European Region, and generally steeper than in adults. The current annual rate of increase is 10 times that in the 1970s [75]. In Switzerland and France, countries with data for the last 40 years, overweight prevalence has increased considerably; in Switzerland it has almost quadrupled since the early 1960s [80]. Other countries have shorter time spans upon which to base estimates but nevertheless dramatic trends emerge, such as in Poland, where childhood overweight (including obesity) is reported to have risen from under 10% in the mid-1990s to almost 20% in 2000 [80]. The rate of increase in overweight and obesity in children is not constant but accelerating: in the 1980s, overweight and obesity prevalence rates yearly increased by less than 0.5 and around 0.1 percentage point respectively; in the late 1990s, yearly increases reached 1.0 percentage point for overweight prevalence and 0.3 percentage point for obesity [76]. The WHO estimates that obesity could affect 15 million children by 2010 in the WHO European Region [75]. Jackson-Leach and Lobstein suggest that over 26 million children in the EU-25 will be overweight (including obese) in 2010, and that this number will be rising by about 1.3 million children each year; of the overweight children, 6.4 million are expected to be obese in 2010, with yearly rises of about 350,000 children [76].
Adults	Based on IOTF data [79], the increase in adult obesity prevalence has been relatively slow in some countries, such as the Netherlands, where from the late 1970s to the beginning of the years 2000 it increased from about 5% in males and 6% in females to just over 10% in both genders. Others rises have been more striking such as in Croatian, Cypriot and Hungarian males, and in English males and females; in these groups, the increase was of at least 10 percentage points over one or two decades. The WHO estimates that if excess body weight continues to increase at the same rate as in the 1990s, obesity will affect 150 million adults by 2010 in the WHO European Region [75].

Obesity prevalence by socioeconomic status and inequalities in obesity

Important variations exist in the prevalence of overweight and obesity not only between European countries (as described above) but also between socioeconomic groups within those countries [5, 83], with variations among regions, population subgroups, and over time. This has major implications for the region, which comprises an extremely diverse population in geography, culture, lifestyle and level of economic development.

Current socioeconomic inequalities in obesity

In Europe, ecological data suggest that obesity prevalence tends to increase with per capita gross domestic product (GDP) up to a level of around $10,000 after which they tend to decrease [5]. A similar pattern is observed for overweight but non-obese adults: a rise in per capita GDP is associated with an increasing prevalence of overweight up to around $10,000, after which there is no obvious trend.

National-level data also suggest that countries with the greatest inequality in wealth have the highest levels of adult and child obesity. Although these findings have to be interpreted with caution, as the comparisons have been made at the population and not the individual level, they suggest that the rise in income inequalities recently observed in many countries – including Bulgaria, Poland, Romania and the Russian Federation – may be associated with an increase in the burden of obesity in the future [5, 83, 84].

Using individual-based data, it appears that a higher risk of obesity tends to be associated with lower socioeconomic status in many high-income European countries. The association is less clear (with sometimes opposite trends) in low-income or transition countries for which data are available. Further details of these and other findings on inequalities in obesity are provided in Table 6.

Table 6. Findings on socioeconomic inequalities in obesity in Europe, along the life course.

Evidence / Life course	Socioeconomic inequalities in obesity in Europe
General	A recent review of the worldwide literature reported overall trends, in both men and women, for an increasing proportion of positive relationships between socioeconomic status and obesity and a decreasing proportion of negative associations in countries as their socioeconomic development (Human Development Index) decreases from high, to medium and low levels; however, variations were observed by socioeconomic status indicator [35]. In high-income European countries, an inverse relationship between socioeconomic status and the risk of obesity has been observed in several countries although data may differ among countries in terms of data sources, definitions of socioeconomic status, and indicators of excess body weight [5, 83]. The raised risk of excess body weight in lower socioeconomic groups tends to be more clearly demonstrated in women and children than in men; of particular concern are female adolescents and women of reproductive age, for whom social inequalities and raised risk of obesity can be detrimental to the health of the population over a long-term period through its action on subsequent generations [5, 83]. In other parts of Europe, the association of socioeconomic status and obesity varies considerably. While in some low-income countries, obesity remains a disease of affluence in both men and women, in a number of middle-income countries a higher risk of excess body weight with lower socioeconomic status is observed in women but not in men [5, 83]. The extent to which the burden of obesity falls on poor people as countries increase their gross national product (GNP) remains an open question. Within countries, it has been observed that members of certain ethnic minority groups tend to have higher levels of excess body weight, especially after several generations of residence in their host countries. These trends could be due to differences in socioeconomic status, including greater exposure to environments conducive to weight gain, but may also reflect culturally-specific health-related behaviour patterns [5, 83].
Women of child-bearing age	Girls and women of reproductive age living in relative poverty are most at risk of developing excess body weight [5]. In some countries such as Estonia, a strong differential between higher and lower social groups for women in their prime child-bearing years has been observed with a narrowing of the gap in later years and no clear socioeconomic status gradient in postmenopausal years. In the age group 25–34 years, the proportion of overweight women in lower income groups is double that in higher income groups [85].
Children and adolescents	Similarly to that of adults, the relationship between obesity and socioeconomic status in European children seems to vary among countries and with national income. In some high-income and in a number of medium-income countries, lower socioeconomic status has been associated with a higher prevalence of obesity in children [83]. With regard to ethnicity, variations are also reported by some authors. For example, it was observed in England in 1999 that the prevalence of overweight was higher in Afro-Caribbean girls and Indian and Pakistani boys compared with the general population [86].

Evidence / Life course	Socioeconomic inequalities in obesity in Europe
Adults	In high-income countries and some medium- and low-income countries, adults in lower socioeconomic status categories experience higher levels of obesity than adults in high socioeconomic status groups, and the social gradient is likely to be a true effect across the total population; this appears to be particularly true for women [5, 83, 87, 88]. In the European Union, results of a study based on surveys conducted in the 1990s and before (but using self-reported data) suggest that the social gradient could account for around 25% of the obesity prevalence in men and 50% in women [89]. In some lower-income European countries such as Azerbaijan and Uzbekistan, obesity remains a disease of affluence in both men and women. Other countries with relatively low income – such as Armenia, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation and Ukraine – show a higher likelihood of excess body weight with higher educational achievement among men, but a lower likelihood with higher education among women in Belarus, the Russian Federation and Ukraine. In countries such as the Czech Republic, Estonia, Latvia, Lithuania and Poland, and a highly urbanised area of Albania, the greater risk of obesity appears to have largely shifted to those with lower socioeconomic status, particularly among women, with most countries having an inverse relationship between education and obesity among women but no significant association among men [83]. In 2004 in the UK, males of Afro-Caribbean origin or from Northern Ireland were more likely to be obese compared to the average prevalence in males in the UK population; a similar observation was reported for females of Afro-Caribbean, Black African [10] or South-Asian ethnicity [90].

Variations in socioeconomic inequalities in obesity over time

In several European counties, obesity prevalence is rising most rapidly in individuals from lower socioeconomic and minority ethnic groups, thus widening the gap between high and low socioeconomic status groups [5, 83]. Table 7 outlines the main findings related to trends in socioeconomic inequalities in obesity in Europe.

Table 7. Findings on trends in socioeconomic inequalities in obesity in Europe, along the life course.

Evidence / Life course	Trends in socioeconomic inequalities in obesity in Europe
Women of child-bearing age	Current evidence suggests that obesity prevalence is rising among low-income younger women more rapidly than among better-off young women [5].
Children and adolescents	Trends similar to those observed in adults might be occurring among children, as suggested by data from England, where the prevalence of overweight and obesity has increased proportionally more during the last decade among children with lower socioeconomic status [91,92].
Adults	Results of several studies, including those of the WHO MONICA project (Multinational **MONI**toring of trends and determinants in **CA**rdiovascular disease project), suggest that socioeconomic inequalities in obesity may be increasing in several European countries; this was based on the observation of a stronger inverse relationship between educational achievement and BMI and larger differences in relative body weight by education [93]. The results of other investigations suggest that Denmark, Finland, France, Portugal and Scotland have experienced a widening of inequalities in obesity [5].

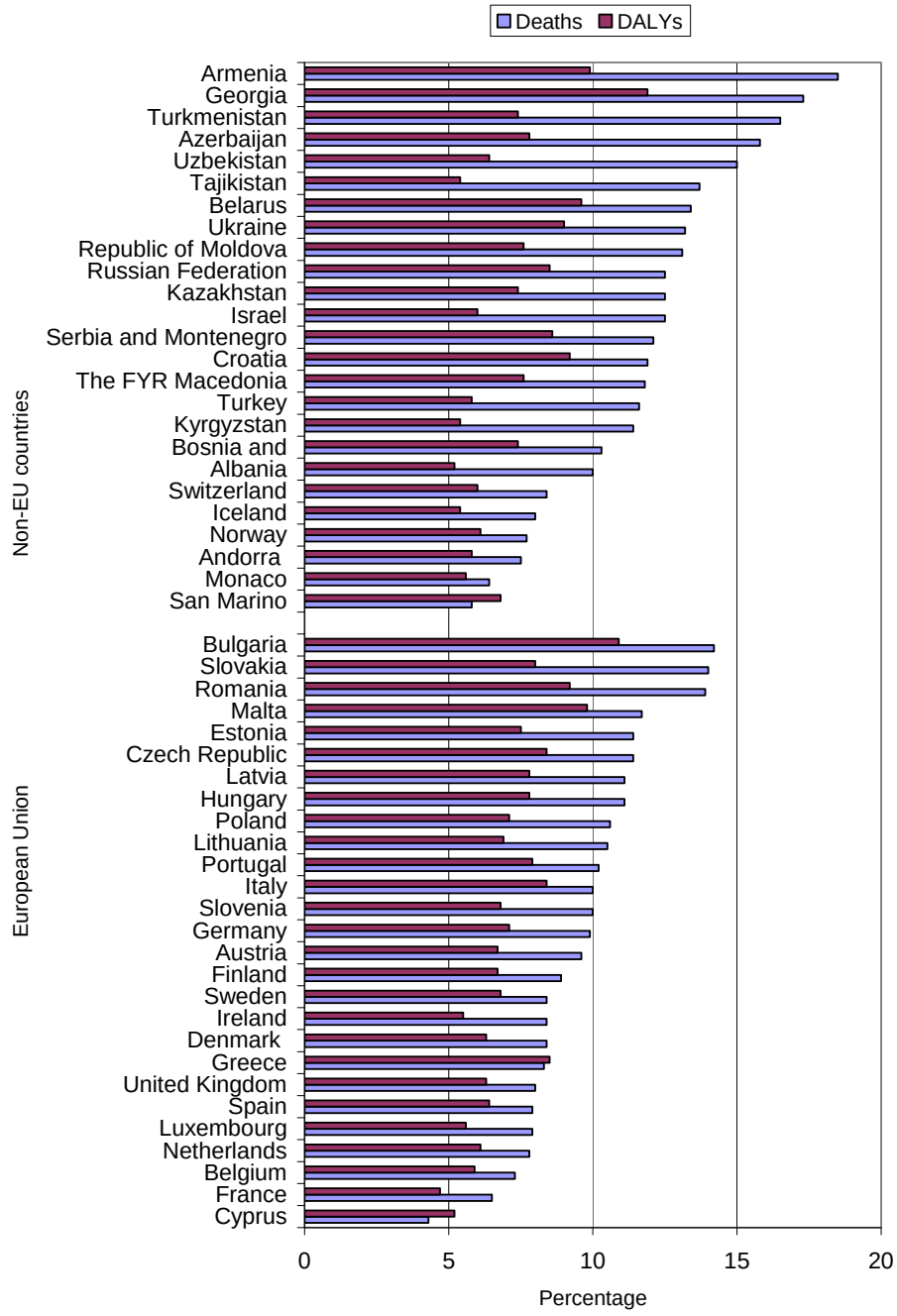
Burden of obesity

Health burden

Overweight and obesity pose a major threat to population health in Europe as they are associated with increased morbidity, disability and mortality. Excess body weight is responsible for about 7.8% of the total burden of disease in Europe (expressed in Disability Adjusted Life Years – DALYs) [94], with variations from about 4 to 18% among countries (Figure 6). The greatest proportion of the global disease burden associated with excess body weight is found in countries of the Commonwealth of Independent States, as well as in the most recent EU members, even though in some of these countries the prevalence of excess body weight is relatively low. This is because obesity acts synergistically with other risk factors, such as untreated hypertension and smoking [95], which are common in these countries [96, 97]. In most countries of the WHO European Region, high BMI is within the top five (out of ten) risk factors contributing to death and DALYs [94]. Disease burden attributable to obesity affects both adults and school-aged children. Moreover sharp social gradients in obesity suggest that a significant health burden during adulthood in children from lower socioeconomic strata could be carried forward from parental socioeconomic status inequalities [98].

Table 8 outlines specific health impacts of overweight and obesity affecting children and adults in Europe. Figure 7 illustrates the proportion of deaths and disease from selected health problems attributable to excess body weight in Europe and Central Asia. It is likely that the continuing epidemic of obesity will lead to reductions in life expectancy and increases in the number of unhealthy life-years, and create high demands on health services in the future.

Figure 6. Percentage of total deaths and disability-adjusted life years (DALYs) attributable to overweight and obesity in EU and non-EU countries of the WHO European Region, 2002.



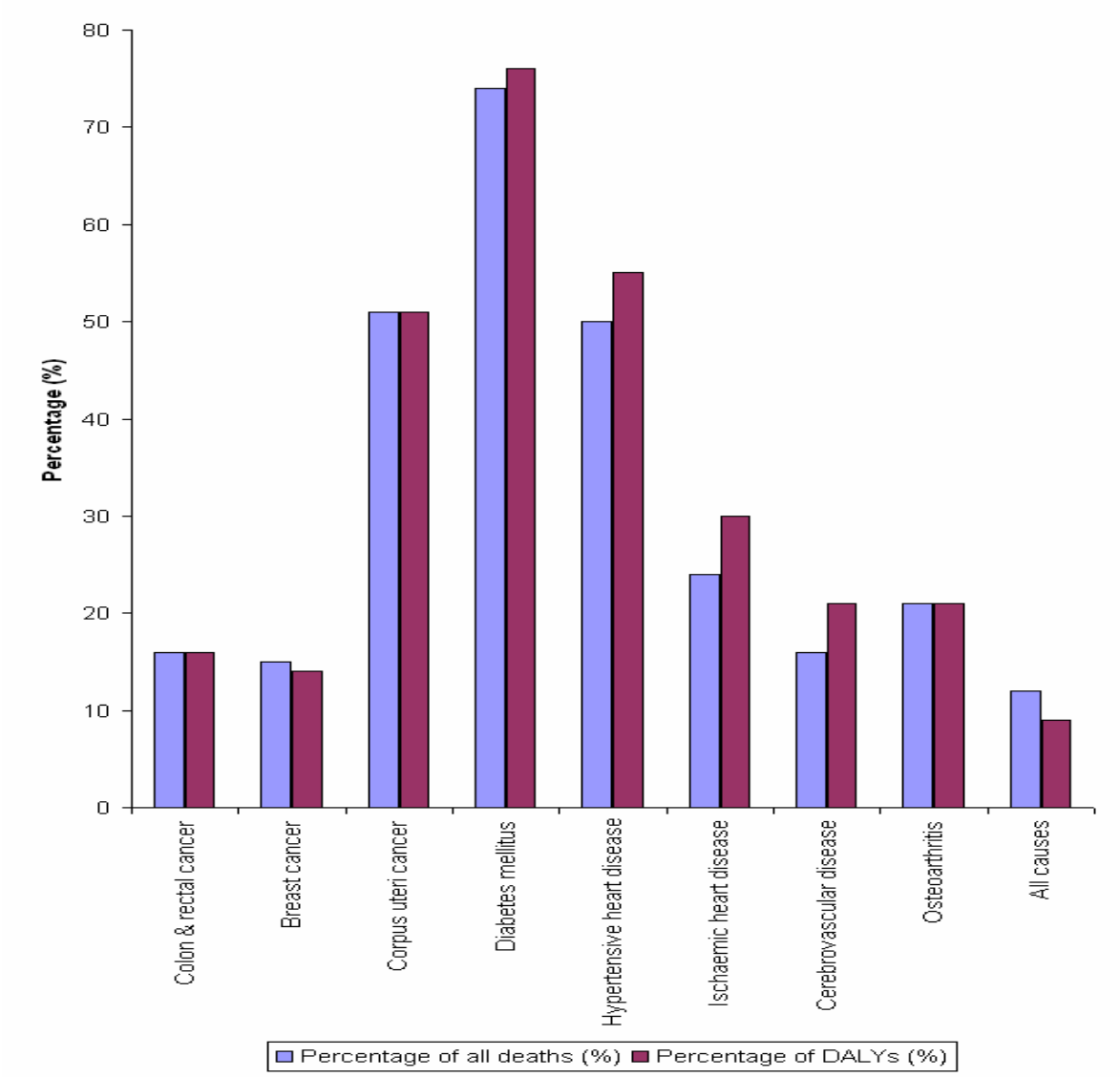
Source: Adapted from the 2005 WHO European Health Report [94].

Table 8. Findings on the health impact of excess body weight in Europe, along the life course.

Evidence / Life course	Health impact of excess body weight
General	Excess body weight has been associated with an increased risk of numerous health problems, including cardiovascular diseases (coronary heart disease, hypertension, and stroke), various types of cancer (endometrial, cervical, ovarian, prostate, breast, colon, rectal, kidney, liver and gall bladder), type 2 diabetes mellitus and insulin resistance, fatty liver disease, osteoarthritis, low back pain, breathlessness, sleep apnoea, pulmonary embolism, deep vein thrombosis, polycystic ovary syndrome, hyperuricaemia and gout, gallstones, reproductive disorders, sexual dysfunction, complications in pregnancy, complications in surgery, oral health problems, as well as psychological and social problems [10, 13, 20, 22, 28, 30, 33, 99]. It has been suggested that obesity could also act as a mediator in the observed harmful effects of income inequalities on health problems such as cardiovascular morbidity and mortality [100]. There is currently an "epidemic' of type 2 diabetes which is driven by the obesity epidemic [101, 102]. Overweight and obesity could account for about 65-80% of new cases of type 2 diabetes; the risk is reported to be a function of the age of onset and the duration of obesity, and weight gain during adult life [103]. Cardiovascular disease and metabolic risks are associated with indicators of abdominal obesity (such as waist circumference) independent of overall corpulence as assessed by the BMI [104, 105]. The World Cancer Research Fund estimates that 30-40% of all cancers can be attributed to inappropriate diet, physical inactivity and overweight [106]. Obesity now appears to be second only to smoking as the most important avoidable cause of cancer. The proportion of disease attributable to excess body weight (but BMI $\leq$30 kg/m^2) may be as high if not higher than that due to obesity (BMI >30 kg/m^2) [99]. In some countries, excess body weight presents a double health burden alongside problems of undernutrition [26, 48, 99]. The association between obesity and mortality remains controversial, however. While some researchers have reported that obesity is not associated with an increased risk of mortality once traditional risk factors for cardiovascular diseases are adjusted for, others suggest that such adjustment is inappropriate (these risk factors being in the causal pathway in the association of obesity with mortality) or that the duration and/or follow-up of the studies were too short [99].
Maternal	Excess body weight has been associated with pregnancy complications and/or labour complications, including a higher risk for caesarean delivery, pre-eclampsia and gestational diabetes [99].
Infants and young children	Excess maternal body weight appears to increase the risk of birth defects such as neural tube defects. It has also been associated with high birth weight, childhood obesity [5, 17, 47] and, in turn, with the risk of becoming obese in adulthood [5].

Evidence / Life course	Health impact of excess body weight
Children and adolescents	Obese children and/or adolescents have an increased risk of metabolic complications (e.g. disorders of glucose/insulin metabolism, metabolic syndrome, polycystic ovarian syndrome (adolescent girls)), cardiovascular problems (e.g. hypertension, left ventricular hypertrophy, dyslipidemia, sleep apnea syndrome), gastrointestinal complaints, orthopaedic complications, and psychosocial problems (e.g. poor self-esteem, withdrawal from social interactions, depression, and anxiety); they often suffer from stigmatisation, which has been reported to result in diminished chances of social and economic performance in adult life [6, 15, 29, 49, 99]. The risks partly depend on the age of onset and duration of obesity. Childhood obesity has also been related to metabolic and cardiovascular consequences in adulthood [6]. In the European Union, it is estimated that 0.5% of obese children (aged 5-17.9 years) have type 2 diabetes (equivalent to over 27,000 obese children) and 8.4% (420,000) impaired glucose tolerance. Almost 24% of obese children (1.2 million) are likely to be affected by the metabolic syndrome (3+ components of the syndrome) and 28% (1.4 million) by fatty liver (hepatic steatosis). In terms of cardiovascular risk factors, 22% (1.09 million) obese children are likely to have raised triglycerides, 22% (1.12 million) raised total cholesterol, 19% (0.96 million) high LDL cholesterol, 19% (0.95 million) low HDL, and 22% hypertension (1.11 million) [107]. Other health problems associated with childhood obesity include sleep-associated breathing disorders such as obstructive sleep apnoea syndrome. As many co-morbidities of obesity are related to the length of time the individual has been obese, as well as the severity of the obesity, sharp social gradients in obesity, such as those observed in French adolescents (nearly one-third of those overweight being in the lowest social grouping), suggest that a significant health burden during adulthood in children from lower socioeconomic strata could be carried forward from parental socioeconomic status inequalities [98].
Adults	The relative impact of obesity on mortality is highest in younger age categories [99]. See also general comments above.
Older people	It has been suggested that waist circumferences may be a better alternative than BMI for identifying elderly men with an increased risk of mortality [108].

Figure 7. Percentage of all deaths and of disability-adjusted life years (DALYs) for selected health problems attributable to overweight and obesity in Europe and Central Asia.



Source: Adapted from Ezzati et al. [109].

Economic burden

Excess body weight has major economic consequences, including direct health care costs, indirect costs associated with lost economic production, and individual costs. Table 9 outlines specific economic impacts of overweight and obesity in Europe. Table 10 gives some illustrations of the direct and indirect costs of obesity in selected European countries, as well as in the United States for comparative purposes. It is important to note that published figures on the estimated costs of obesity may vary widely among countries and studies in part due to methodological issues (e.g. different estimation approaches which lead to different estimates – such as using a disease-based approach compared with an individual-based approach; different definitions of obesity, population structures or systems of health care; single-year versus lifetime estimates) [110].

In Europe, the total costs of obesity are estimated to be considerable and appear to be growing. In the 15 countries that were part of the European Union before May 2004, the total direct and indirect annual costs of obesity reached €32.8 billion in 2002, equivalent to 0.3% of the gross domestic product [111]. Furthermore, this figure is likely to be conservative as it does not take account of overweight adults and of the health consequences of excess body weight in children and adolescents [110]. Some researchers have suggested that the effect may be more pronounced in transition or low-income economies [80, 112]. In Poland, for example, one study reported that treatment costs of obesity and its complications account for approximately 21% of the total health care budget, corresponding to nearly €3 billion [113]; another study, extrapolating data from one area in Poland, estimated national costs of €1 billion for the direct treatment of obese patients [71].

While it is generally accepted that obesity prevention programmes may reduce the short-term economic burden of obesity, their effect on long-term costs is more controversial [110]. Indeed, as people adopt better lifestyles, they are likely to be healthier in the short term and require less health care, thus leading to short-term health savings. However, in the long term, individuals will live longer and may suffer from other health problems (such as dementia) that are associated with frequently used and costly care. Some have argued that there is a risk that later costs could exceed the initial savings. However, it should be noted that most health care costs associated with old age are linked more closely to proximity to death than to chronological age. Furthermore, it is important to include the economic value of the additional years of life lived [114]. The impact of obesity prevention programmes is nevertheless expected to be associated to both short- and long-term gains in economic productivity and reduced indirect costs.

Table 9. Findings on the economic burden of excess body weight in Europe, along the life course.

Evidence / Life course	Economic burden of excess body weight in Europe
Direct costs	Direct costs cover the different types of health care costs (including the costs of obesity treatment, and obesity's health consequences) [110]. Data presented in Table 10 suggest that health expenditure attributable to obesity in European countries ranges from about US$17 to US$202 per person. The direct health care costs of obesity in the WHO European Region account for approximately 2-4% of national health expenditure [111]. In the Netherlands, excess body weight (BMI >25 kg/m^2) accounts for 2% of total health care expenditure, compared with 3.7% for smoking, 3.3% for high blood pressure, 1.4% for physical inactivity, 0.8% for insufficient fruit consumption, 0.3% for insufficient vegetable consumption, and 0.4% for alcohol consumption; the largest health expenditures were for coronary heart disease, diabetes and musculoskeletal disease [115]. In England, direct costs of obesity were reported to have increased between 1998 and 2002 [116]. This was due to the recognition of new co-morbidities in the analysis, to increased drug costs, drug take-up and availability, higher medical staff costs and higher earnings in the economy as a whole, as well as an increase in the number of obese persons. The costs of treating obesity rose from £9.5 million to £45.8–49.0 million during that period (this was in large part due to a major increase in the cost of prescriptions for anti-obesity drugs (£0.8 million to £31.3 million)), while the costs of treating obesity's consequences increased from £469.9 million to £945–1075 million. In a recent study, Allender and Rayner [7] estimated that the cost of diseases directly attributable to excess body weight in the UK was £3.23 billion in 2002; of this amount, the largest proportion was due to stroke (£983 million, followed by coronary heart disease (£773 million), hypertensive disease (£576 million) and diabetes mellitus (£533 million). With regard to overweight individuals (BMI 25–29.9 kg/m^2) although the link between overweight and health care costs is not as strong as that reported for obesity, the absolute costs of overweight are likely to be significant given the high number of overweight persons [110].

Evidence / Life course	Economic burden of excess body weight in Europe
Indirect costs	Indirect costs of obesity are associated with productivity loss due to underperformance, to absence from work owing to ill health, or to premature death [42, 110]. While it is generally accepted that obese individuals tend to have a higher risk than others of being absent from work, the impact of this higher absence is known to depend on the situation of the labour market (absent employees might be replaced by unemployed people, thereby reducing indirect costs – friction cost approach) and the structure of the social security system (e.g. employers' payments to employees during illness). Although fewer studies have estimated the indirect costs of obesity, it has been suggested that they are considerably higher than the estimated direct health costs [34, 110]. Figures provided in Table 10 suggest that indirect costs attributable to obesity range from about US$17 to US$157 per person.
Individual costs	These include spending on domestic care, special clothing or slimming products [110]. Some authors also describe how obesity imposes costs to individuals by limiting personal opportunity in various ways (e.g. discrimination, social exclusion, lower wages and income, job loss, personal health care costs) [34, 42, 110]. An interesting aspect of the economic 'attributes' of obesity is the two-way association of obesity with income levels and poverty, with the lack of economic opportunity increasing the likelihood of becoming obese on the one hand, and obesity potentially reducing economic opportunity on the other hand [34, 42, 110].

Table 10. Cross-sectional estimates of the direct costs of obesity in selected European countries.

Country study, year of estimate, BMI cut-off point (kg/m²)	*Costs*			
	Type	*Per capita (US$ at PPP*)*	*% total current expenditure on health*	*% GDP **
European countries				
Belgium, 1999, ≥30 [117]	*Direct*	*69*	*3*	
France (range), 1992, ≥30 [118]	*Direct*	*71–148*	*0.6–1.3*	
France, 1992, ≥27 [119]	*Direct*	*202*	*1.8*	*0.9*
Germany (range), 2001, ≥30 [120]	*Direct*	*17–35*	*1.2–2.6*	*0.1–0.3*
	Indirect	*17–38*		
Netherlands / 1993 / ≥30 [121,122]	*Direct*	*32*	*1.7*	
Sweden, 2003, ≥30 [123]	*Direct*	*45*	*1.8*	*0.7*
	Indirect	*157*		
Switzerland, 2001, ≥25 [120]	*Direct + indirect*	*186*		*0.6*
United Kingdom (England, range), 2002, ≥30 [116]	*Direct*		*2.3–2.6*	
EU (15 countries), 2002, ≥30 [124]	*Direct + indirect*			*0.3*

Source: Adapted from World Health Organization [110]

*PPP = purchasing power parity. PPP controls for differences in purchasing power. This means that a dollar may have more value in terms of consumption in one country than in another;

**When both direct and indirect costs have been calculated in the same study, the total cost as percentage of gross domestic product (GDP) is the sum of both direct and indirect costs.

4. Determinants of obesity and inequalities in obesity in Europe

This section summarises current evidence on the determinants of and inequalities in obesity by discussing food and nutrition and physical activity as broad determinants of obesity, presenting the evidence for the general population and for disadvantaged populations, at each stage of the life course, and focusing on social environment, poverty and inequalities, as these are linked to determinants of obesity and in turn, to risk in weight gain [84]. These factors cut across age groups and determinants to make the cycle of obesity all the more difficult to break. The main findings of reviews are summarised according to the EURO-PREVOB conceptual framework presented above, and prefaced by brief sections outlining key findings on the physiological and psychosocial determinants of obesity.

Physiological factors

There are important physiological determinants of obesity, as summarised in Table 11; these depend on the interactions between genetic background, energy and nutrient availability, physiological conditions and particularities (e.g. hormonal balance), affecting growth throughout the life course [e.g. 8, 9], and compounded by socioeconomic inequalities [5].

Table 11. Findings on physiological determinants of obesity in Europe along the life course, among the general and disadvantaged populations.

Evidence / Life course	Physiological determinants of obesity
Maternal	An underweight pregnant woman puts her foetus at risk (via biological programming) of obesity in later life [8]. An overweight pregnant woman has greater risk of delivering a high birth-weight infant (>4000 g) which in turn can increase the risk of childhood and adult obesity [5, 8, 47]. Women who are overweight or obese before pregnancy are less likely to initiate breastfeeding and they discontinue breastfeeding earlier than do normal-weight women [125, 126]. Obese women in low socioeconomic groups appear to have personal, social, and economical constraints which may influence their decision to breastfeed or not [127]. Low-income mothers have more difficulty in losing the excess weight gain after birth [128, 129].
Infants and young children	Impaired foetal growth followed by rapid catch-up in infancy is a strong predictor of obesity and co-morbidities [8]. The link between obesity and low birth weight as well as high birth weight is a current cause of concern [5]. There is a possible link between breastfeeding and the prevention of obesity in later life [43, 46, 54, 130]. Breastfeeding will also help avoid baby-bottle tooth decay [131]. Early childhood caries, which are a serious problem in disadvantaged communities, put young children at risk of poor diet, given the importance of healthy teeth in the ability to eat nutritious foods such as fruits and vegetables [132].
Children and adolescents	BMI is high in young infants, but shows an initial fall during the 2nd to 5th year of life. A second increase ('adiposity rebound') occurs at 5-8 years or later [133]. An earlier adiposity rebound leads to a greater risk of subsequent obesity [8]. Tracking of BMI-for-age across the lifespan is relatively strong during childhood into adulthood [134, 135]. The risk of a child being overweight appears to increase with parental overweight and obesity [136, 137, 138]. Dental caries in young adolescents are common and put them at risk of poor diet, given the importance of healthy teeth in the ability to eat nutritious foods such as fruits and vegetables [139, 140].

Evidence / Life course	Physiological determinants of obesity
Adults	As highlighted by the Foresight report [2], research into the metabolic aspects of human energy expenditure has provided limited evidence to explain the disregulation of energy balance [141]. There is little evidence to support the assumption that obese people must have slower metabolic rates. In fact, the converse appears to be true: resting energy expenditure actually increases with body weight, and after adjustment for differences in body size and composition, energy expenditure between individuals is very similar [141]. There is also little evidence on any basic physiological difference, or on a protective mechanism in lean individuals, when comparing normal-weight individuals to obese individuals [141]. Furthermore, controlled experimental studies suggest that lean and obese individuals have similar rates of weight gain or loss [142]. Thus physiological differences between people are likely not the root cause of obesity [141].
Older people	Body weight tends to decrease after age 60. Fat tends to be redistributed with advancing age toward more abdominal fat [108, 143, 144]. Older people without teeth or with periodontal disease consume fewer fruits and vegetables and more saturated fat and energy-dense food than those who retain their teeth, and are at increased risk of becoming obese [145].

Psychosocial factors

The psychological and social determinants of obesity are considerable for people of all ages, as outlined in Table 12. Psychosocial factors such as anxiety due to discrimination, societal pressure to adopt certain norms, or the cultural and social pressures of adapting to new environments can be reasons for weight gain, as well as the result of weight gain, and are compounded by socioeconomic disadvantage.

Table 12. Findings on psychosocial determinants of obesity in Europe along the life course, among the general and disadvantaged populations.

Evidence / Life course	Psychosocial determinants of obesity
Infants and young children	Psychosocial deprivation and poverty are two among several important risk factors for obesity in school children [146]. Young people from lower socioeconomic groups are more likely to report poor psychological well-being, lower life satisfaction and more psychosomatic health complaints (such as difficulty sleeping, headache, stomach ache, feeling low and feeling nervous), all of which have been reported to be associated with excess weight gain [147].
Children and adolescents	
Adults	Reviews on the psychosocial aspects of obesity highlight the pressure to be thin and the assumption (even among health care professionals) that being overweight is a sign of poor self-control [148, 149, 150], all of which contributes to the spiral of poor psychological status and weight gain [151]. Differences in attitudes towards weight gain and in weight-control practices could also contribute to socioeconomic variations in obesity, with people of lower socioeconomic status having lower levels of perceived overweight, monitoring their weight less closely, being less likely to try to lose weight and less frequently using restrictive dietary practices than those with higher socioeconomic status [152]. Chronic work stress has been directly associated with risk of general and central obesity (waist circumference) [153]. Refugees settling into new countries, and particularly if in socially deprived residential areas, can suffer psychologically due to lack of social cohesion and support systems and greater likelihood of discrimination, thus increasing the risk of weight gain [154, 155].
Older people	In older people psychosocial factors are related to isolation, poverty and the stress of such situations [156], leading to poor eating habits and poor physical activity levels, as described below, and thus increasing the risk of obesity.

Food environment

Dietary habits

Diets rich in fats, salt and sugar, including high intake of sugar-sweetened beverages, are most associated with excessive weight gain [37, 157] while a healthy, nutrient-dense, balanced diet may be associated with a decreased risk of obesity [158]. Low-income groups tend to have relatively high-energy and low-micronutrients diets compared with high-income groups [1, 5, 38], thus putting them at additional risk of weight gain. Table 13 summarises key findings on dietary habits as determinants of obesity in Europe, for general and disadvantages populations.

Table 13. Findings on dietary habits as determinants of obesity in Europe along the life course, among the general and disadvantaged populations

Evidence / Life course	Dietary habits as determinants of obesity
Maternal	Excessive energy intake during pregnancy (i.e. an energy increase greater than about 200 kcal /day during the last trimester) and during lactation (an energy increase greater than 380–500 kcal /day) can increase the risk of obesity [159].
Infants and young children	Breastfeeding has been associated with a reduction of overweight in later life [130, 160, 161, 162, 163]. There appears to be a dose-dependent association between longer duration of breastfeeding and decreased risk of overweight [43, 164, 165]. The early introduction of food appears to be associated with higher infant weight at one year [166, 167].
Children and adolescents	High fatty, salty and sugary snacks with larger standard portion sizes may contribute to weight gain in children and adolescents [168, 169]; those from low-income families tend to eat less fresh fruit and vegetables and more sugar and sweets, fats, processed meats, salty snacks and soft drinks compared with those from higher income households [170, 171]. Refugee and migrant children in Europe appear to consume too much fat and insufficient amounts of micronutrients [172, 173, 174], putting them at additional risk of obesity.
Adults	Lower socioeconomic status adults tend to consume more processed meat, fat and sugar, less fruit and vegetables and to skip breakfast than higher socioeconomic status adults [175, 176, 177, 178, 179, 180]. Socially vulnerable groups are at greater risk than others of having an unhealthy diet [181].
Older people	Functional oral health problems such as tooth loss and mastication problems could contribute to poor dietary habits and the increased risk of obesity in older people [182, 183].

Food supply and access to healthy food and drink

Dietary patterns are influenced by the affordability, accessibility, availability, attractiveness, appropriateness, and practicality of foods and drinks [184, 185]. Increases in food supply and a related fall in prices, as well as the increasing presence and influence of multinational food corporations, have influenced the above factors, contributing to the nutrition transition, and thus to the obesity epidemic. Table 14 summarises key findings in this area for general and disadvantages populations.

Table 14. Findings on food supply and access as determinants of obesity in Europe along the life course, among the general and disadvantaged populations

Evidence / Life course	Food supply and food access as determinants of obesity
Infant and young child	The home environment, including parental food preferences, and school environment influence the development of eating habits, with single parenthood, low parental education and employment increasing the risk of energy-dense, nutrient-poor diets and thus obesity in children [186]. Schools run the risk of reinforcing inequalities, for example, by subcontratcting lunch programmes which encourage the sale of low quality foods [187]. Foods and beverages most heavily marketed are often energy-dense, micronutrient-poor products [83, 188]. Such marketing campaigns often target children and can bypass parental control; they utilise various techniques and channels to foster brand building and influence food-purchasing behaviour [83].
Children and adolescents	
Adults	The cost of food may be one barrier to adopting healthier diets, especially among low-income households. Low-income adults may find it harder to access a variety of good quality, affordable food, may spend a relatively higher proportion of their income on food, and face financial, physical and psychosocial constraints [189]. The relatively low cost of energy-dense, nutrient-poor foods, combined with their high palatability and low satiating power, high convenience and increased prevalence of marginal cost pricing (super-sizing) may have contributed to an increase in energy-dense food consumption between meals and in higher amounts of food consumed at each meal (larger portion sizes) [190, 191, 192]. The fact that energy-dense foods cost less per unit energy than do nutrient-dense foods suggests that energy-dense diets are not only cheaper but may be preferentially selected by the individuals with fewer resources [16]. Fruit and vegetable intake tends to be higher in Europeans with a higher education level; however, in regions where these foods are more available and consumption more common (e.g. southern Europe), it appears that the lower social classes tend to consume more of these foods than the higher social classes [193]. Meals are increasingly eaten away from home and these meals, especially fast food, tend to have higher energy density and larger portion sizes than food consumed at home [192, 194].
Older people	Older people suffering from food insecurity are at risk of excess weight, either because of poverty or a disability [195]. Solitude at meal time reduces food variety and psychosocial well-being, increasing the risk of poor nutrition in older people [196, 197, 198]. Food insecurity in the elderly may be exacerbated by poor access to shops due, for example, to inappropriate public transport [199, 200].

Natural and built environment

Physical activity

Physical inactivity, sedentary lifestyle (little or no physical activity during leisure time and in everyday life) and its associated low energy expenditure are a known major risk factor for obesity [201]. Although it is generally accepted that low physical activity levels are associated with body weight gain over time, the question of causality can be questioned as increased body weight and obesity may also be associated with decreased physical activity, therefore a complex, and sometimes circular, relationship may develop [202]. Table 15 outlines what is known about physical activity as a determinant of obesity in Europe among the general and disadvantaged populations.

Table 15. Findings on physical activity as a determinant of obesity in Europe along the life course, among the general and disadvantaged populations

Evidence / Life course	Physical activity as a determinant of obesity
Maternal	Regular moderate exercise can reduce risk of excess weight in mothers with no adverse effects on the mother and foetus [203, 204]. Low-income and poorly educated adults are more likely to have lower levels of physical activity [205].
Infants and young children	Low socioeconomic status children tend to be less physically active and more sedentary than those with a higher socioeconomic status [184, 206].
Children and adolescents	Some researchers have suggested a relationship between TV viewing and physical activity (inactivity) but the evidence is conflicting [207, 208]. Some evidence points to the fact that television viewing in children may be associated to unhealthy food consumption [209] and physical inactivity. Television viewing may thus carry a greater risk of excess weight gain. These links may also exist in young people from lower socioeconomic status [210]. This is possibly because television viewing may be positively associated with physical inactivity combined with the consumption of foods high in sugar and fats (e.g. sodas, crisps, cakes and pastries, and sweets and chocolates) [211].
Adults	Low socioeconomic status adults tend to be less physically active and more sedentary than their wealthier counterparts [206], possibly due to them having less leisure time (low socioeconomic status adults are more likely to be active through work) and financial resources [212]. In particular socially marginalised people and immigrant groups in European countries appear to have great difficulty being as physically active as they would like to be [58, 213]. It has been suggested that individuals with a higher socioeconomic status may experience more social pressure to exercise and be more knowledgeable or have more positive attitudes about the benefits of exercise [184, 214, 220].
Older people	Excess weight in people over 65 years may be related to mobility-related disabilities associated with old age [215, 200].

Physical environment

The physical environment, including the social, school and work environments, transport systems and urban design can promote or inhibit physical inactivity in the general population as well as inequalities in physical activity levels [39, 216]. Disadvantaged populations typically have few places at their disposal that encourage a healthy lifestyle such as safe, well-lit streets and pavements, low crime, low traffic, parks, paths and community gardens [217]. There may be important variations across countries or regions (though these are not well known) [39].

Table 16 summarises main observations on the association of obesity with the physical environment.

Table 16. Findings on physical environment as a determinant of obesity in Europe along the life course, among the general and disadvantaged populations

Evidence / Life course	Physical environment as a determinant of obesity
Infants and young children	Higher academic demands, less importance attached to physical education and unstructured play and exercise at school, as well as the lack of equipment for physical education classes, contribute to less overall physical activity [218, 219]. The home environment can influence the development of physical activity habits in children. Low-income and low-education households are associated to sedentary behaviour and physical inactivity, [220] Physical activity in children has been positively associated with the provision of pavements ('sidewalks'), destinations to walk to, few intersections to cross, low road traffic hazards, proximity to, and availability of parks, playgrounds, and recreation areas [225].
Children and adolescents	
Adults	There may be an inequitable distribution of and access to affordable physical activity-related facilities, programmes and opportunities to exercise between low and high-income groups [212, 221, 222, 223, 224]. There is reasonable evidence that aspects of the built environment and of urban form may influence physical activity, for example it has been related to access to physical activity facilities, convenience, high residential density, perceived safety and availability of footpaths 225. Communities where disadvantaged people live are associated with obesity [226], with higher odds of physical inactivity and obesity compared with people living in a more advantaged neighbourhood [227]. Also, high level of disorder in neighbourhoods and lower access to facilities such as shops, financial services and municipal pools have been significantly associated with obesity in the UK [228]
Older people	Factors such as traffic and inadequate road crossings can be impediments for older people to be more physically active [200]. Urban dwellers will have better access to places for physical exercise compared with those living in rural areas [229, 230, 231]. Thus older people in urban centres may be more active which, in turn, improves their ability to function and improve their access to health and social services.

5. Gaps in knowledge and future directions

Many recent studies have tried to clarify the distribution of excess body weight in Europe, the nature of socioeconomic inequality in obesity, and the determinants of obesity. Yet, more information remains needed.

Epidemiology of obesity in Europe

A major issue is the current lack of data on the distribution of and trends in excess body weight in several countries, and the caveats of the data available, as described above. This highlights the need for a robust European monitoring system for both children and adults that would cover similar age groups and include various markers of inequalities. The chosen system should examine levels of excess body weight as well as both low and high birth weights and their relationship with socioeconomic status. Standardised methods of assessing excess body weight and socioeconomic status should be used to facilitate comparisons between countries. Newly developed data collection instruments should pay attention to gender and cultural specificity, such as the country-specific economic context, financial situation within the household, indicators of social position and cultural constraints specific to women. Surveillance systems should also include the monitoring of socioeconomic variation in dietary intake, physical activity patterns and diet-related community

weight-control practices. The double burden of overweight and undernutrition should also be examined in European populations.

Future research should also aim to provide more accurate and comprehensive estimates of the direct and indirect costs of obesity and of how these vary over time and among countries.

Determinants of obesity and inequalities in obesity in Europe

Studies should be designed to help identify groups that are particularly vulnerable to socioeconomic inequality in obesity in each country and investigate the specific individual and ecological circumstances promoting this inequality and the interaction between the social, behavioural and biological determinants of inequalities in obesity [14].

Repeated surveys would help to show how the relationship between socioeconomic status and obesity changes over time; this is particularly relevant for low- and medium-income countries undergoing economic transition. Longitudinal studies would provide further information on socioeconomic differences in obesity from a life-course perspective, on the health consequences of excess body weight (including age of onset of obesity-related morbidity, and long-term excess weight), and on whether these change between countries. Both quantitative and qualitative research is needed to understand the complexities of the association between socioeconomic status and obesity.

Finally, investigation into obesity should continue to look not only at energy intake and expenditure but at the environment in which people live, taking into consideration social stratification.

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