Obesity and the Economics of Prevention
Fit not Fat

Chapter 2

Obesity: Past and Projected Future Trends

Obesity has risen to epidemic proportions in OECD countries during the last 30 years. In this chapter, the development of the epidemic is discussed in the light of evidence from a range of OECD countries. After a comparative overview of current obesity rates in OECD and selected non-OECD countries, the recent obesity epidemic is set in the context of historical developments in height, weight and body mass index (BMI). Using BMI as the reference measure to identify individuals who are overweight or obese, a detailed analysis is presented of how rates have grown in OECD countries in the past 30 years, accounting for differences in the likelihood of obesity across birth cohorts. The final section of this chapter presents OECD projections of further growth of overweight and obesity rates in the next ten years in adults and children.

Obesity in the OECD and beyond

It is no surprise that obesity has risen to the top of the public health policy agenda in virtually all OECD countries. The latest available data (up to 2007) collected by the OECD on overweight and obesity rates show that over half of the adult population is overweight in at least 13 countries, including Australia, the Czech Republic, Greece, Hungary, Iceland, Ireland, Luxembourg, Mexico, New Zealand, Portugal, Spain, the United Kingdom and the United States. In contrast, overweight and obesity rates are much lower in Japan and Korea and in some European countries, such as France and Switzerland. However, rates are also increasing in these countries.

In non-OECD countries such as Brazil, China, India, Indonesia, Russia and South Africa, rates are still somewhat lower than in OECD countries, but increasing at similarly fast rates. In China, where rapid changes in dietary habits are exacting a large toll (Baillie, 2008), overweight rates doubled from 13.5% to 26.7% between 1991 and 2006. The obese are a small proportion of these, but tripled over the same period of time (Lu and Goldman, 2010). New estimates suggest that the prevalence of diabetes, the chronic disease which is most closely linked with obesity, in China is as high as in the United States, with over 92 million cases (Yang *et al.*, 2010). In Brazil, obesity rates grew threefold in men and almost doubled in women between 1975 and 2003 (Monteiro *et al.*, 2007). Smaller increases in overweight were recorded in India (rates for women increased from 10.6 to 12.6 between 1998-99 and 2005-06), but increases were much steeper in west urban areas, where rates approached 40% in the early 2000s, almost doubling in less than ten years (Wang *et al.*, 2009). Overweight and obesity have taken over as the predominant features of malnutrition in South Africa (Puoane *et al.*, 2002), where one third of women and one tenth of men are obese (WHO Infobase), with highest rates among black women and white men. After the recent political and economic transition, obesity grew also in the Russian Federation, where one in four women and one in ten men are now obese, and rates are projected to grow fast in the coming years (WHO Infobase). The global dimension of the obesity epidemic is illustrated very well in Barry Popkin's book *The World is Fat* (Popkin, 2009).

The prevalence of obesity in adults varies more than tenfold among OECD countries, from a low of 1 in 33 in Japan and Korea, to one in three in the United States and Mexico. The number of people who are obese has more than doubled over the past 20 years in the United States, while it has almost tripled in Australia and more than tripled in the United Kingdom. Between one in four and one in five adults are obese in the United Kingdom, Australia, Iceland and Luxembourg, about the same proportion as in the United States in the early 1990s. Figure 2.1 shows a comparison of obesity rates available from OECD and selected non-OECD countries, for men and women.

Measuring obesity

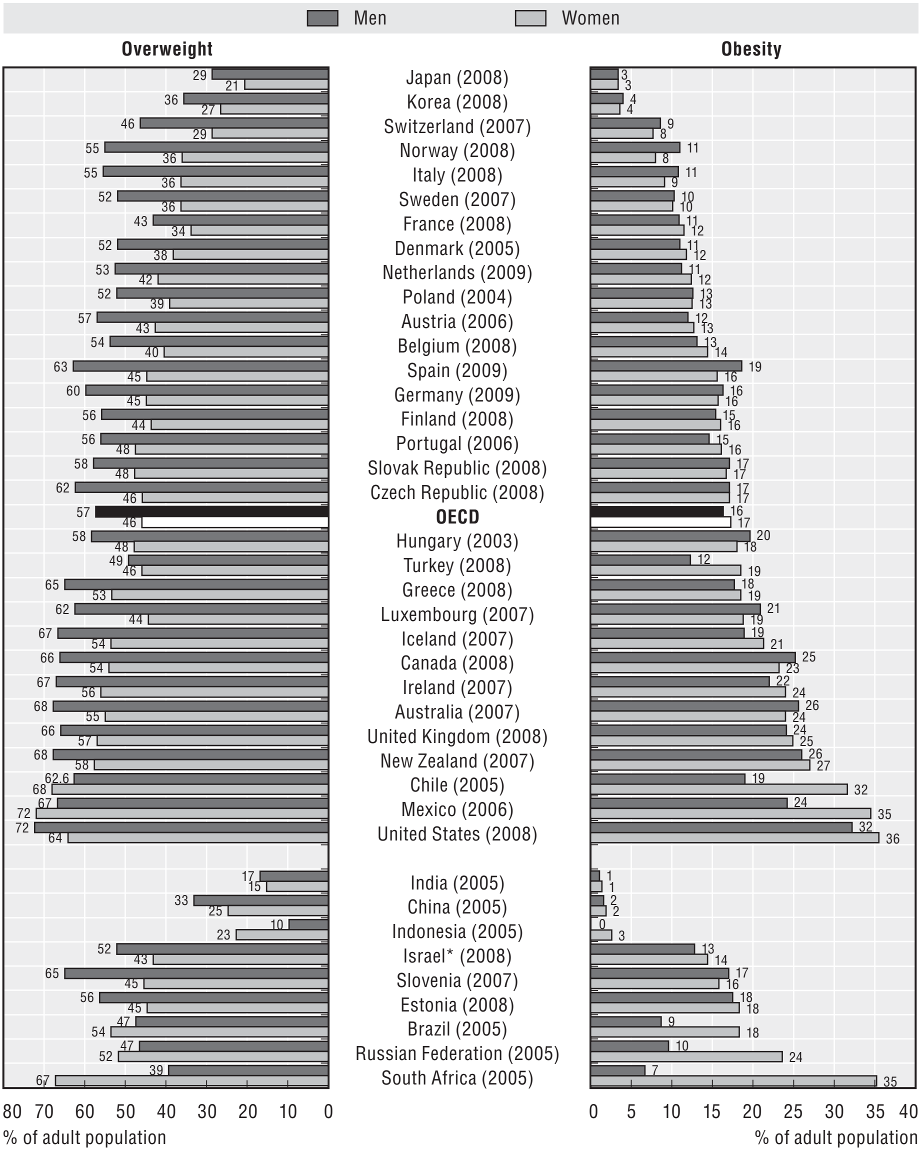
According to the WHO, overweight and obesity are meant to reflect abnormal or excessive fat accumulation – also called adiposity – that may impair health. The measurement of adiposity is difficult, therefore proxies are normally used based on more easily measurable anthropometric characteristics. The body mass index (BMI),[1] a measure of body weight-for-height, is the most well known proxy for adiposity, dating back to the 19th century.

Modern use of BMI dates from 1972. Until then, obesity was defined by reference to an "ideal body weight" derived from life insurance actuarial tables. In 1972, obesity researcher Ancel Keys published the results of a study of almost 7 500 men in five countries. Keys compared a number of formulas to see which was the best predictor of body fat measured directly, and the equation proposed by Belgian scientist Adolphe Quetelet proved more accurate than alternatives such as weight divided by height. Keys renamed Quetelet's index "body mass index". Based on BMI data, the WHO concluded in 1997 that obesity had reached epidemic levels worldwide.

The US National Institutes of Health started defining obesity by BMI in the 1980s. In 1998, they defined a BMI of 25-29.9 as "overweight", and 30 and above as "obese". Based on these thresholds, a woman of approximately average height in the OECD (1.65 m, or 5 feet 5 inches) is overweight if she weighs 68 kg, and obese if she weighs 82 kg. A man of average height (1.75 m, or 5 feet 9 inches) is overweight if he weighs 77 kg, and obese if he weighs 92 kg. There are suggestions that lower thresholds should be used in Asian populations (WHO, 2004), as well as in certain ethnic minority groups, because increasing patterns of health risks have been observed in those populations starting from lower BMI levels.

BMI's main advantages are that it is simple and provides easily remembered cut-off points. But many researchers criticise it for not taking into account important factors such as age, sex and muscularity, so that using BMI alone can contribute to the so called "obesity paradox", where certain degrees of excess weight can even appear to offer protection against some conditions in certain population groups (Lewis *et al.*, 2009). Critics argue that waist measurement, for example, or the waist-to-hip ratio, are better indicators of abdominal fat and associated health risks. Keys himself stressed

Figure 2.1. **Obesity and overweight in OECD and non-OECD countries**



Note: For Australia, Canada, Czech Republic, Ireland, Japan, Korea, Luxembourg, Mexico, New Zealand, Slovak Republic, United Kingdom and United States, rates are based on measured, rather than self-reported, body mass index (BMI).

* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Source: OECD Health Data 2010; and WHO Infobase for Brazil, Chile, China, India, Indonesia, Russian Federation and South Africa.

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that BMI was useful for epidemiological research, but warned against using it for individual cases.

Despite continued controversy on the use of BMI as a marker of risk (Cawley and Burkhauser, 2006), a very large study of the link between obesity and mortality published in 2009 concluded that BMI is a strong predictor of mortality, and that different proxy measures of adiposity are more likely to be complements than substitutes, as each can provide additional information relative to others (Prospective Studies Collaboration, 2009).

Historical trends in height, weight and obesity

Height and weight have been increasing since the 18th century in many of the current OECD countries. Height increases have been closely related with economic growth (Steckel, 1995), although early industrialisation brought about periods of slight shrinkage of average height in countries such as Great Britain and the United States (Komlos, 1998). The British were the tallest population in Europe in the 18th century, on average they were about 5 cm taller and had a 18% larger calorie consumption than the French. Americans were even taller, by as much as 6-7 cm over the average height of a Briton, and continued to be the tallest until at least the second half of the 19th century, when their growth in stature slowed down, relative to northern European populations, and the latter took over as the tallest in the 20th century.

Over the same period of time, weight and body mass also increased gradually, until increases in BMI accelerated sharply in many OECD countries starting from the 1980s. Norwegian men aged 50-64 increased their body mass by approximately one point in the 18th century, by 3 points in the following century and by a further 3 points between 1870 and 1975 (Fogel, 1994). In the subsequent 25 years alone, average BMI in the same group grew by at least two additional points (Strand and Tverdal, 2006; Reas *et al.*, 2007). American men of the same age increased their average BMI by 3.6 points between 1910 and 1985-88, and by almost the same amount in the following single quarter of a century. Average BMI increased by 1.5 points in England over 15 years, from the early 1990s to the mid-2000s, and by 1 point in France in the same period.

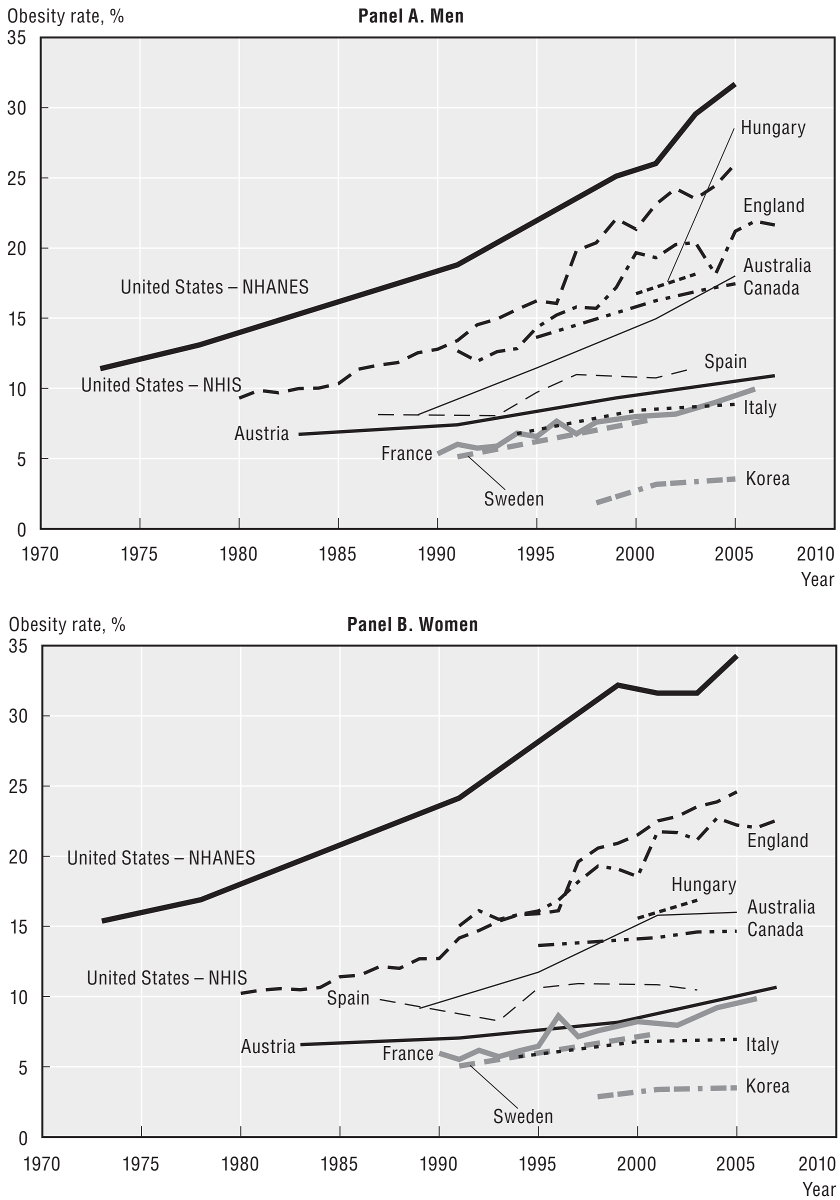
The changes described have clear implications on longevity. Nobel laureate and economic historian Robert Fogel makes use of Waaler curves, named after the Norwegian economist who developed them, to investigate the links between height, weight and mortality. In a three-dimensional view, Waaler curves draw a mountain-like shape (Mount Waaler, as Angus Deaton calls it – Deaton, 2006) where mortality is highest at the bottom and lowest at the top. Mankind has gradually climbed this mountain, progressively growing in height, weight and BMI, and enjoying an ever longer life span. But the trajectory of this journey does not aim straight to the top of the mountain. The ascent has been slowed down by an excessive gain in weight-for-height, and the current acceleration in BMI growth has further deflected the trajectory. The populations of most OECD countries are beginning to circle around the top of the mountain, rather than pointing straight to it.

Following the growth in BMI described above, overweight and obesity rates have been increasing consistently over the past three decades in all OECD countries. Obesity has been increasing at a faster pace in countries with historically higher rates, leading to a widening gap among countries over time. Conversely, pre-obesity[2] has been growing faster in countries with historically lower rates. In countries with high rates of overweight and obesity (*e.g.* United States, England) rates of pre-obesity stabilised or even began to shrink in recent years, while obesity rates continued to rise. The reason for the different trends in obesity and pre-obesity is explained below in the final section of this chapter. The size of the pre-obese category in a population depends both on the rate at which normal weight people become overweight (inflow) and on the rate at which pre-obese people become obese (outflow). The relative changes in the obese and pre-obese categories depend therefore on changes in the shape of the overall BMI distribution over time (see Figure 2.5 below).

The OECD carried out a detailed analysis of individual-level national health examination and health interview survey data, using surveys from the following 11 OECD countries: Australia, Austria, Canada, England, France, Hungary, Italy, Korea, Spain, Sweden and the United States. All of the available waves of these health surveys were used in the analyses, providing a temporal coverage that varies from 4 (Hungary) to 31 years (United States). The surveys used provide the most accurate and detailed information currently available on overweight and obesity, assessed with reference to the body mass index (BMI) , which is directly measured in three of the 11 countries (England, Korea and the United States) and based on self-reported height and weight in the remaining eight. Details about the surveys used and the years covered are available in Table A.1 in Annex A.

Figure 2.2 shows the pace of growth of obesity rates in the working-age populations of the above OECD countries, accounting for differences in the age structures of the relevant populations. Obesity rates have been increasing in all OECD countries in men (Panel A). Similar increases have been observed in women in Australia, Austria, Canada, England, France, Hungary, Sweden and the United States whereas the corresponding curves for Italy, Korea and Spain in Panel B are virtually flat or show minimal increases over time. Obesity rates in England and the United States are substantially higher than in the other countries, and over five times those observed in Korea. The same BMI thresholds were used in all countries to define overweight (BMI of 25 and over) and obesity (BMI of 30 and over). The two trend lines for the United States in the figures are based on two different surveys: the National Health and

Figure 2.2. **Age-standardised obesity rates, age 15-64, selected OECD countries**



Note: For England, Korea and the United States (NHANES) rates are based on measured, rather than self-reported, body mass index (BMI). Rates are age-standardised using the OECD standard population.

Source: OECD analysis of national health survey data.

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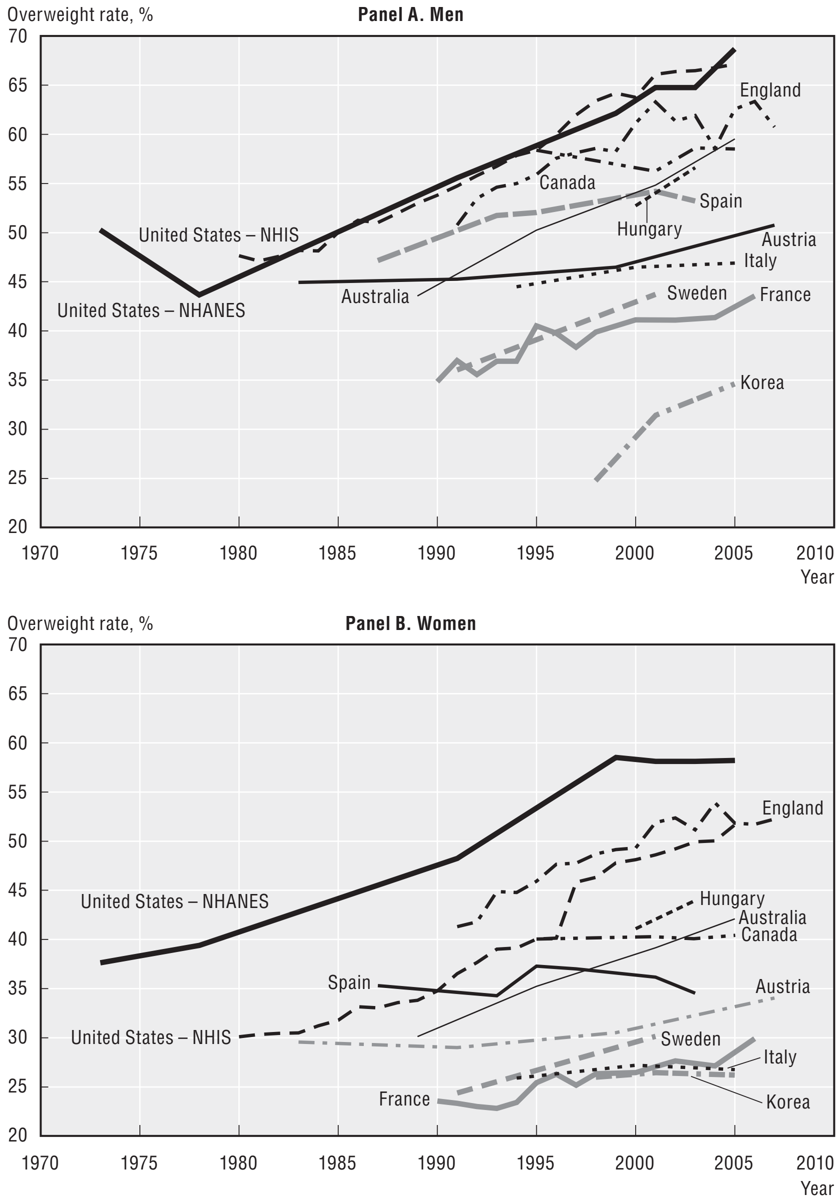
Figure 2.3. **Age-standardised overweight rates, age 15-64, selected OECD countries**



Note: For England, Korea and the United States (NHANES) rates are based on measured, rather than self-reported, body mass index (BMI). Rates are age-standardised using the OECD standard population.

Source: OECD analysis of national health survey data.

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Nutrition Examination Survey (NHANES) using measured BMI, and the National Health Interview Survey (NHIS) using self-reported BMI. Self-reported rates from NHIS under-estimate obesity compared to actual rates reported in NHANES, but the time trends are the same.

Overweight rates, shown in Figure 2.3, have been increasing for men in all countries except in Canada. Overweight rates display less variation than obesity rates: US rates for overweight are twice as high as Korean rates, while the difference in obesity between the two countries is roughly eightfold. Overweight rates in women (Panel B) show an increase over the years except for Italy, Korea, and Spain, whose curves are virtually flat.

Cohort patterns in overweight and obesity

There is substantial evidence of the role of both individual characteristics and environmental influences in the development of overweight and obesity, but less is known about the way these factors have acted over time, and on the relative contribution they made to the current obesity epidemic. In an effort to fill this gap, we carried out a statistical analysis known as age-period-cohort (APC) analysis using individual-level health survey data for around 1.8 million individuals aged 15-65 from six OECD countries. The aim was to gain an improved understanding of how the obesity epidemic developed, disentangling the relative contributions to the epidemic of different types of factors (*e.g.* individual *vs.* environmental) which are likely to act differently over time. Failure to distinguish different temporal effects makes it difficult not only to interpret the observed relationship between BMI and age, but also to extrapolate observed time trends into the future.

The countries studied were Canada, England, France, Italy, Korea and the United States. The three time-related factors were:

- *Age*: biological and lifestyle changes typically characterise a given age group, for example physiological capacities, accumulation of social experience, or time spent on different activities such as exercise.
- *Period of observation*: period effects reflect events experienced at a given point in time, including cultural, economic, or environmental changes, which affect all individuals simultaneously. Environmental factors also affect every individual in a population at the periods when the surveys were undertaken.
- *Birth cohort*: individuals in a cohort are exposed to similar influences at key stages throughout their lives, for example nutrition received in the early years of life or the type of education, and share a number of characteristics that vary over time.

We pooled data from cross-sections of various waves of the health surveys undertaken in each of the countries, adjusted to account for sample size differences across waves. We devised separate APC models for the six countries and two outcome measures (overweight and obesity). BMI was measured in England and Korea and self-reported in the rest, but was assessed consistently over time in each of the surveys.

In brief, the APC analysis confirms the importance of period effects (an actual increase in the prevalence of overweight and obesity in all six countries over the periods surveyed) but suggests that the pace of the increase in overweight and obesity may be underestimated in analyses which do not fully account for age and cohort effects.

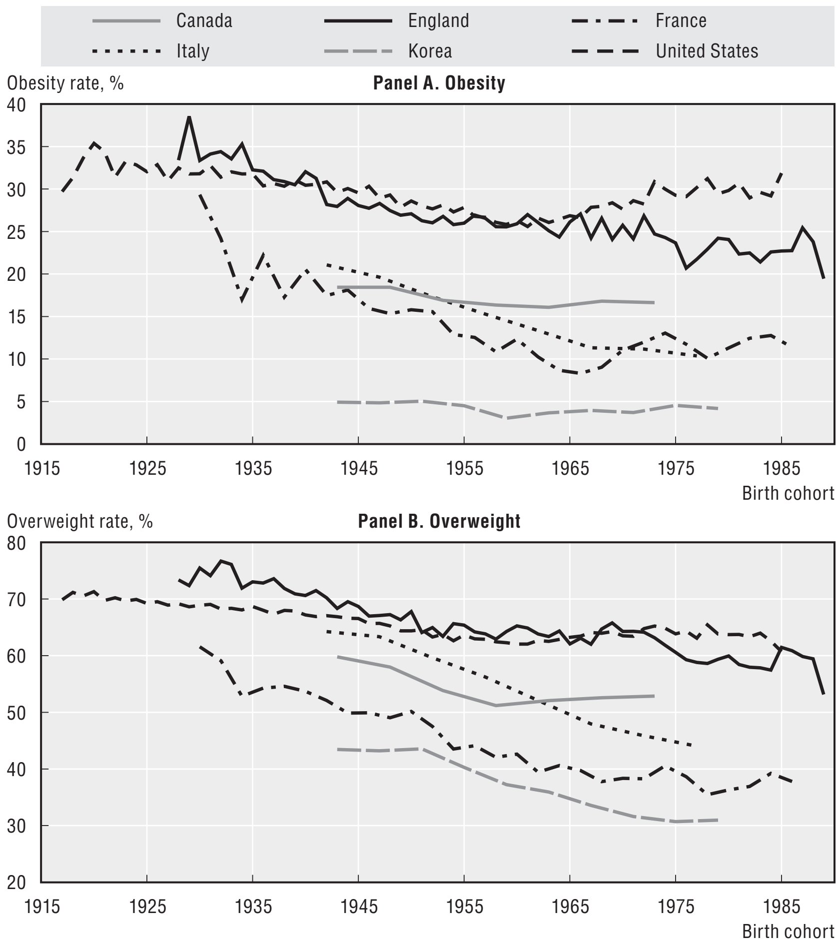
Factors and dynamics that have characterised recent decades have sharply increased everyone's likelihood of becoming overweight or obese, regardless of their age or birth cohort, reflecting the powerful influences of physical, social and economic environments that favour obesity.

Looking at the results in more detail (Figure 2.4) shows that the underlying probability of obesity of successive birth cohorts was generally declining in the earlier part of the 20th century, until showing signs of an upturn in Canada, France and the United States (and possibly Korea) from the 1960s. This was not observed for overweight, where cohort trends consistently declined apart from Korea.

There are a number of possible explanations for the mostly declining cohort trends identified in our analysis. First, education and socio-economic status have improved substantially since World War II. Both of these factors are associated with lower probabilities of obesity in OECD countries. Individuals born in the earliest cohorts observed in our analysis, dating back to the 1920s and 1930s, are likely to have been exposed to more limited education, especially health education, than those born later. When we accounted for individual education (based on highest qualification achieved) and occupation-based social class, cohort effects were attenuated but still showed a decline. Material living conditions and nutrition are also likely to have been poorer, on average, for the earliest cohorts. The role of material deprivation, particularly food deprivation, during childhood as a factor that may increase the likelihood of obesity in later life is highlighted in a number of studies, and this effect may be stronger in women than in men.

Negatively sloped and relatively small cohort effects suggest that the large increases in overweight and obesity rates observed since the 1980s are attributed primarily to factors and dynamics that have characterised the latter time period, which have sharply increased everyone's likelihood of becoming overweight or obese, regardless of their age or birth cohort. These factors and dynamics reflect the powerful influences of obesogenic environments (aspects

Figure 2.4. **Cohort patterns in obesity and overweight in selected OECD countries**



Source: OECD analysis of national health survey data.

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of physical, social and economic environments that favour obesity), which have been consolidating over the course of the past 20-30 years, and are behind the increasing period effects resulting from the APC analysis.

Projections of obesity rates up to 2020

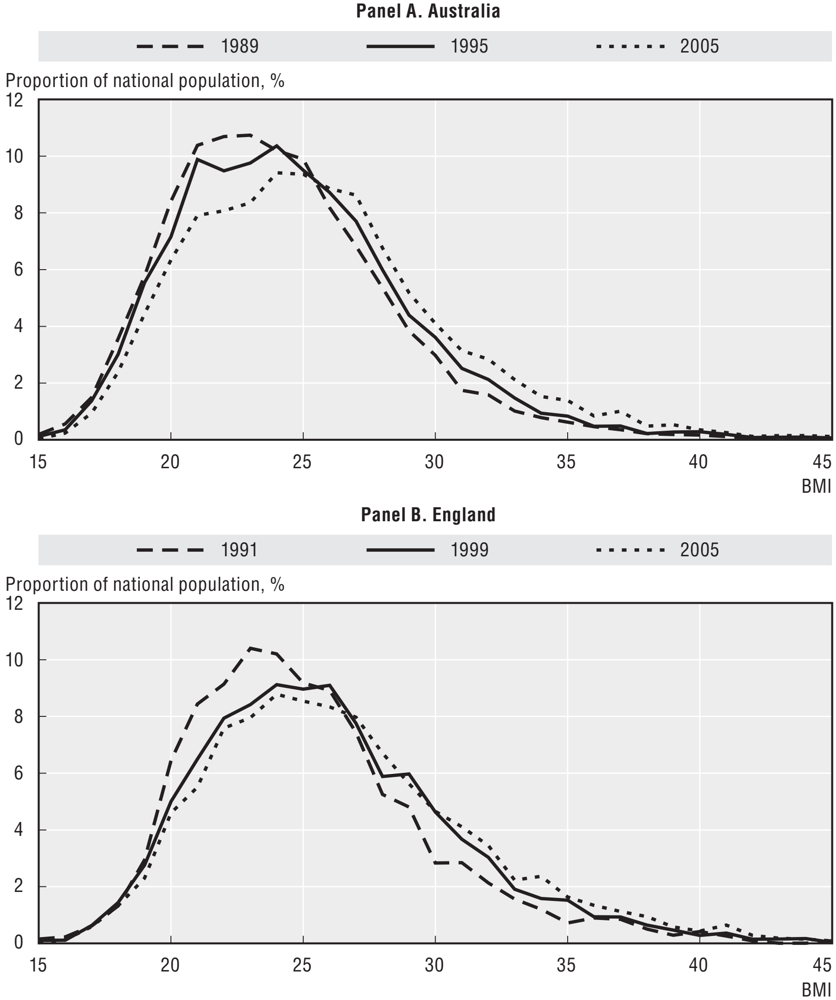
The distributions of BMI across the national populations of OECD countries have been shifting over time following a typical pattern. This pattern does not reflect a uniform increase in BMI across national populations. Rather, it is consistent with a progressive increase in BMI in a substantial group, determining a gradual transition of such group from the left-hand side of the distribution (normal weight) to the pre-obese section first, and then to the obese section. This pattern has been particularly marked in countries like Australia, England and the United States and is illustrated in Figure 2.5. This pattern of change has led to an increase in the spread of the BMI distribution, which means increasing inequalities in BMI over time. It is also likely to mean that overweight rates will stop growing in the not too distant future, although the proportion of people with the highest levels of BMI among those who are overweight will continue to increase. In practice, the prevalence of pre-obesity will stabilise when those who move from pre-obesity to obesity will be as many as those moving from normal weight to pre-obesity. If those moving "out" were even more than those moving "in", the prevalence of pre-obesity would decrease.

We projected trends in adult overweight and obesity (age 15-74) over the next ten years in a number of OECD countries (Figure 2.6), based on the assumption that the entire distribution of BMI in national populations would continue to evolve following the patterns observed in the past. The projection model accounts for a possible non linearity of time trends in overweight and obesity rates. However, the resulting projections should be read as extrapolations of past trends into the future. As such, they are implicitly based on the assumption that the factors that have determined the rate changes observed in recent years, including policies adopted by governments to tackle emerging trends, will continue to exert the same influence on future trends.

OECD projections predict a progressive stabilisation or slight shrinkage of pre-obesity rates in many countries (*e.g.* Australia, England, United States), with a continued increase in obesity rates. Increases in overweight and obesity are expected to happen at a progressively faster pace in countries (*e.g.* Korea, France) where rates of obesity were historically lower. It is conceivable, although not necessarily proven by the data, that the pattern observed in Australia, Canada, England and the United States is simply a later stage in a progression that Austria, France, Italy, Korea and Spain may experience further down the line, unless key determinants of such progression are dealt with in the near future. In the absence of effective interventions, countries with historically low rates of overweight and obesity, such as Korea, may expect within the next ten years to reach the same proportions of pre-obese population (BMI between 25 and 30) as countries that currently rank near the top of the BMI league table, such as England.

Obesity is more common in older age groups, within the age range examined, and appears to be growing at slightly faster rates than in younger age groups in several countries. However, changes in the age structures of national populations in the OECD area are unlikely to have contributed in a major way to past increases in overweight and obesity, or to contribute to expected future increases.

Figure 2.5. **Changes over time in the BMI distribution in Australia and England**



Source: OECD analysis of national health survey data.

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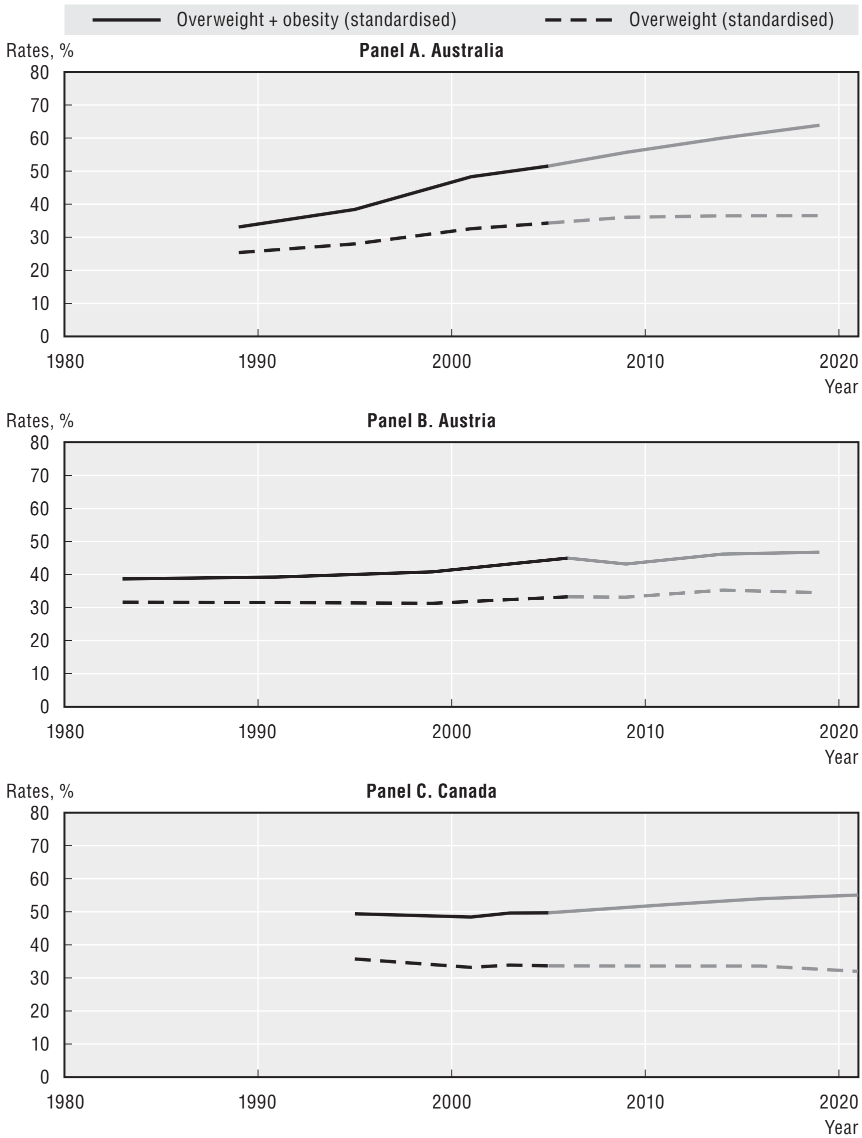
Similar projections were made for child overweight and obesity (age 3-17) over the next ten years in England, France, Korea and the United States (Figure 2.7). The same assumptions as for adults were made,[3] however, given a higher degree of uncertainty concerning expected future changes in child obesity, two alternative statistical approaches were used to estimate a possible range of variation in future overweight and obesity estimates. Only one approach was used for Korea, because of a more limited availability of past trend data.

Figure 2.6. **Past and projected future rates of obesity and overweight, age 15-74, selected OECD countries**



Source: OECD analysis of national health survey data.

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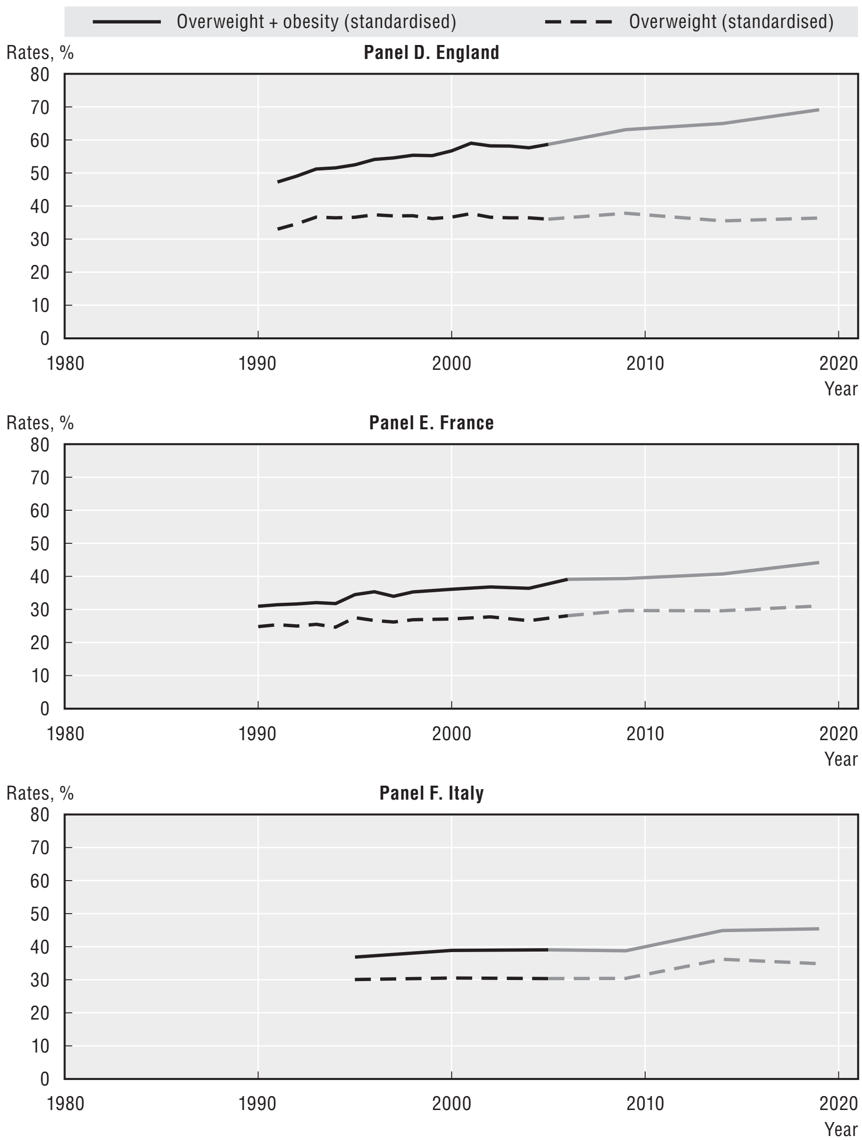
Child overweight and obesity increased substantially in England and in the United States between 1990 and the early 2000s, with overweight rates reaching peaks of nearly 40% around 2005. In the most recent years, there have been signs of a stabilisation or even a possible slight retrenchment of overweight and

Figure 2.6. **Past and projected future rates of obesity and overweight, age 15-74, selected OECD countries** *(cont.)*



Source: OECD analysis of national health survey data.

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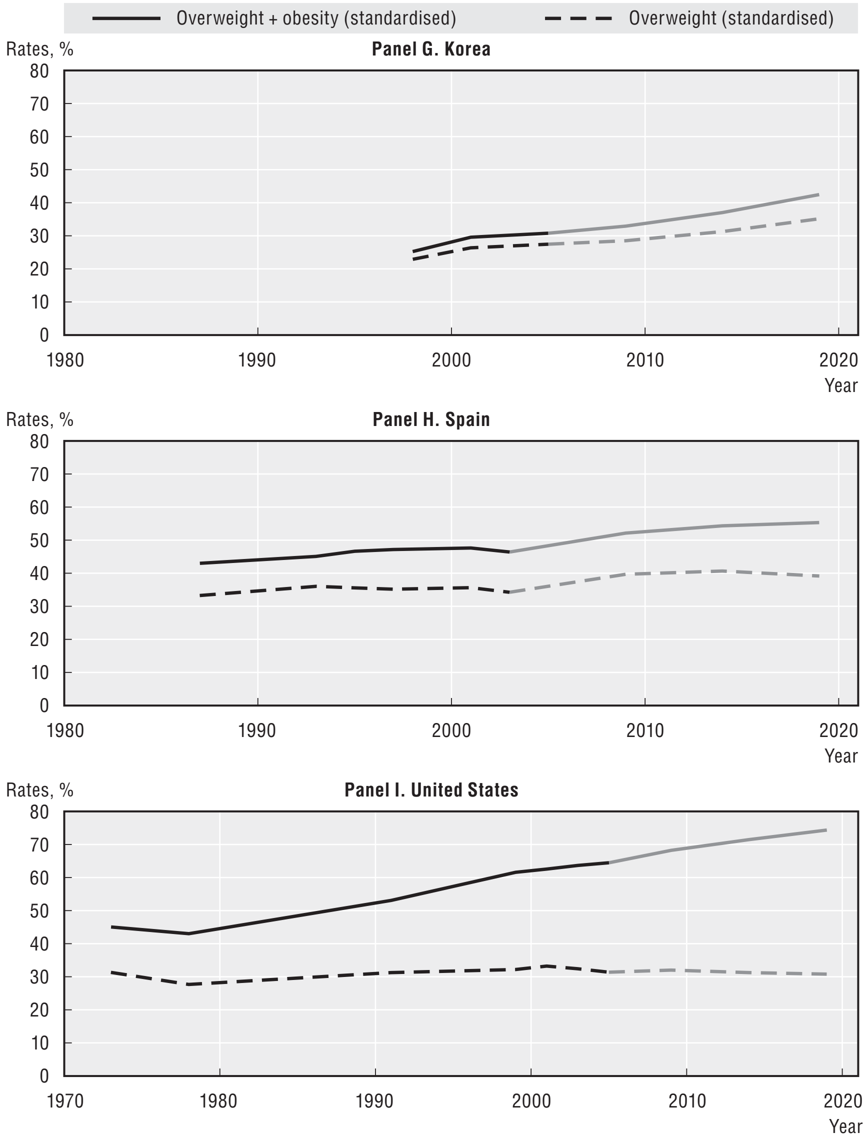
obesity in the above two countries. OECD projections suggest that these trends may push overweight rates further up or down by up to 7-8% relative to current rates. The range of variation in projections is slightly smaller for obesity rates, but with rates more likely to increase in the United States.

Figure 2.6. **Past and projected future rates of obesity and overweight, age 15-74, selected OECD countries** *(cont.)*



Source: OECD analysis of national health survey data.

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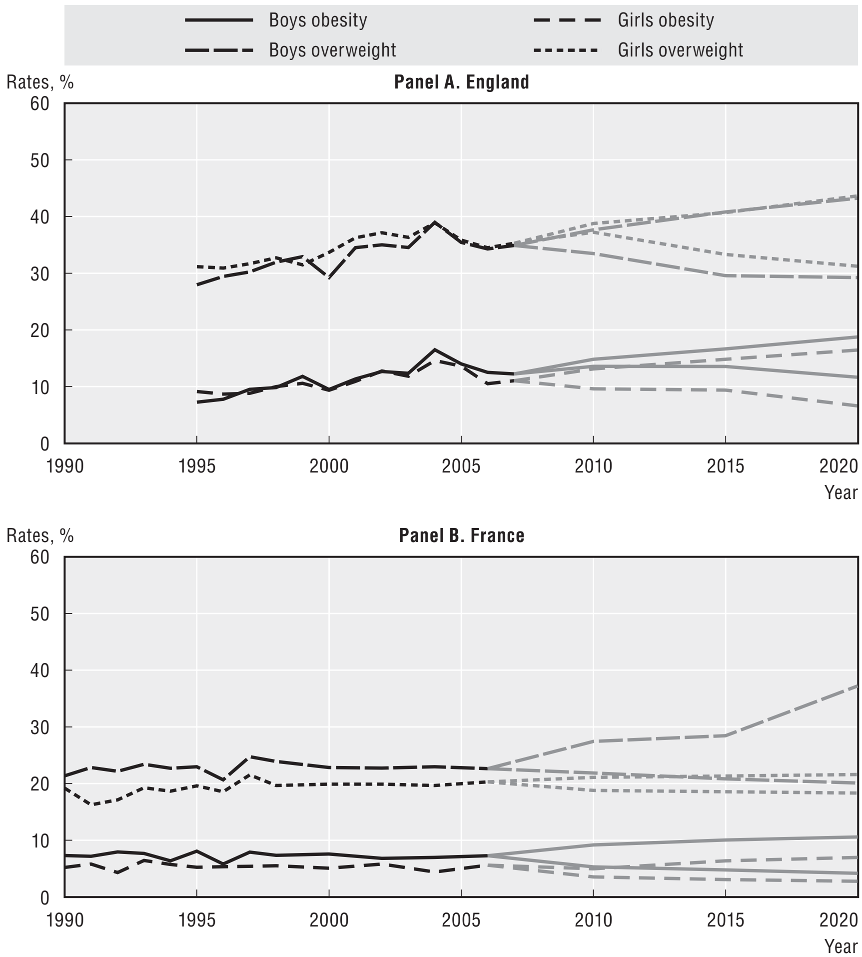
Trends in child obesity are different in France, where rates have been consistently lower than in the previous two countries and relatively stable over the past 15 years.[4] Thus, the range of variation in projections is substantially

Figure 2.7. **Past and projected future rates of child obesity and overweight, age 3-17, in four OECD countries**



Source: OECD analysis of national health survey data.

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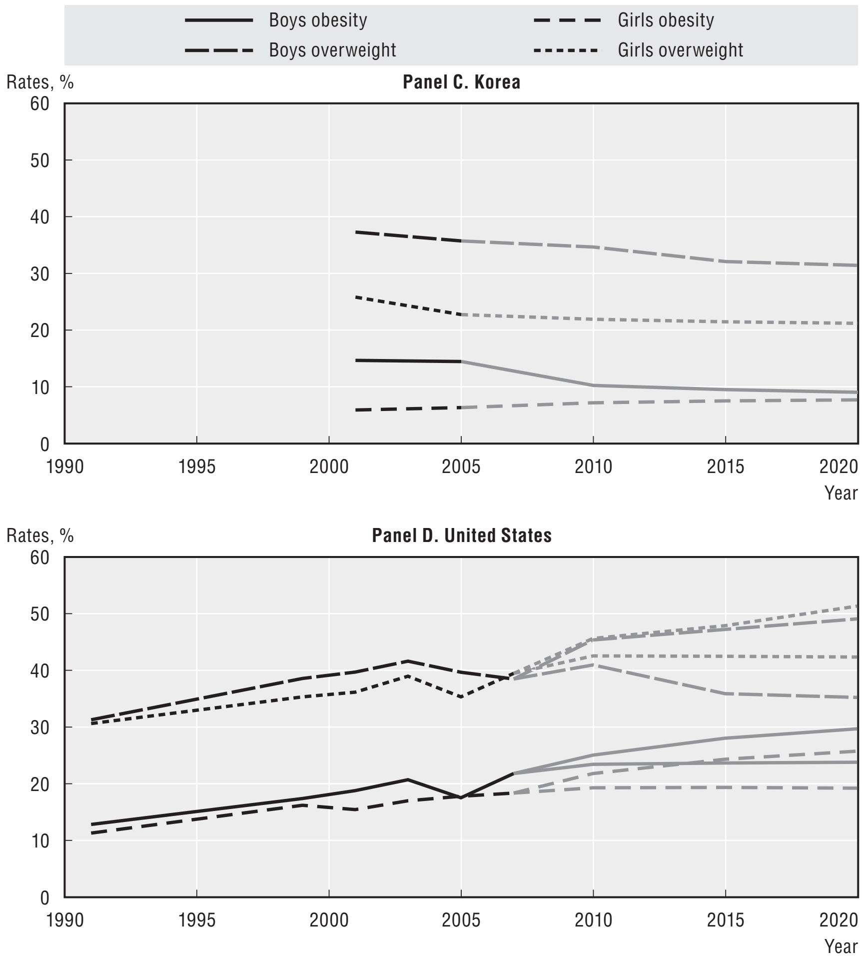
smaller than for England and the United States, although the possibility of a relatively large increase in overweight in boys over the next ten years cannot be ruled out, based on existing evidence. The two data points available for Korea reveal high rates of obesity and overweight, mainly in boys. Projections show a likely slight decrease of overweight and a stabilisation of child obesity.

Figure 2.7. **Past and projected future rates of child obesity and overweight, age 3-17, in four OECD countries** *(cont.)*



Source: OECD analysis of national health survey data.

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Key messages

- Obesity has risen to epidemic proportions in the OECD area during the past 30 years. Rates are still somewhat lower in major non-OECD countries, but growing at a similarly fast pace as in higher income countries, especially in urban areas.
- Over 50% of the population is currently overweight in almost half of OECD countries. Rates are highest in the United States and Mexico, where about one in three adults is obese. In Europe, rates are highest in the United

Kingdom, where one in four adults is obese. On the other hand, rates are up to ten times lower in Asian OECD countries.

- Height, weight and body mass have been increasing gradually at least since the 18th century, contributing to a steady progress in life expectancy. The rapid acceleration in BMI growth over the past 30 years will likely slow down further progress in longevity.
- The obesity epidemic has largely been determined by factors and dynamics that have characterised the last 30 years, which have created obesogenic environments. Improved education and socio-economic conditions have decreased the underlying probability of obesity in successive birth cohorts.
- OECD projections envisage a progressive stabilisation or slight shrinkage of pre-obesity rates in several countries (*e.g.* Australia, England, United States), with a continued increase in obesity rates.
- Increases in overweight and obesity are expected to happen at a progressively faster pace in countries (*e.g.* Korea, France) where rates of obesity have been historically lower.
- Projections of child overweight and obesity are more uncertain, as periods of stabilisation, or even slight shrinkage, have followed previous rate increases in several OECD countries.

Notes

1. The simple formula for the body mass index is weight in kilograms divided by square height in meters.
2. The terms pre-obese/pre-obesity are used here, in line with WHO recommendations, to identify individuals who are overweight but not obese, *i.e.* with a BMI of 25 and above, but lower than 30.
3. The definitions of overweight and obesity applied to children differ from those applied to adults. Instead of the conventional BMI thresholds of, respectively, 25 and 30, age-specific thresholds are used to define overweight and obesity in children, based on current knowledge of the link between BMI and health status. At least two sets of thresholds have been used extensively in the assessment of child obesity, one developed by the International Obesity Task Force (IOTF) (Cole *et al.*, 2000), the second by the World Health Organisation (age 0-5: *www.who.int/childgrowth/standards/bmi_for_age/en/index.html*; age 5-17: *www.who.int/growthref/who2007_bmi_for_age/en/index.html*). When applied to assess the prevalence of overweight and obesity in children, the two sets of thresholds may lead to substantially different estimates. Key differences between the two sets and underlying approaches are discussed in Monasta *et al.* (2010) and in De Onis and Lobstein (forthcoming). The analyses of child overweight and obesity undertaken by the OECD, including analyses of past and projected future trends and analyses of disparities by socio-economic status and by ethnicity, reported in this chapter and in Chapter 3 are all based on WHO thresholds, while the data presented in Tim Lobstein's special contribution which follows Chapter 3 in this book are based on IOTF thresholds.

4. It should be noted that past trends in child obesity calculated by the OECD for France differ from those reported in Tim Lobstein's special contribution which follows Chapter 3. In the latter, overweight rates are shown to have increased substantially during the 1990s. This is due to the use of different data sources, different age groups (3-17 in the OECD analysis, 5-11 in the analysis in T. Lobstein's contribution), and different criteria for defining overweight (see note 3 above).

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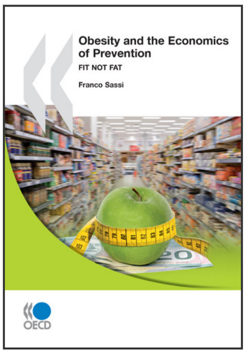
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