

Report of Royal Society policy seminar on the scientific understanding of obesity

1 Summary of key points and proposed actions from the seminar

- There is optimism that increased understanding of the science of obesity and careful evaluation of interventions will accelerate progress in both its prevention and treatment. Obesity encompasses many different conditions. Identifying their causes should lead to more focused treatments and better preventative strategies.
- Strategies to manage obesity more satisfactorily will decrease the number of patients with chronic diseases that are directly (eg osteoarthritis) and indirectly (eg type II diabetes, hypertension, coronary heart disease, stroke, some types of cancer and psychological conditions) related to obesity.
- Many different types of study are aiding our understanding of obesity and related chronic diseases. These include research into the genetic, molecular, physiological and behavioural aspects of obesity, and epidemiological studies including considerations of maternal and foetal influences. The studies are at an early stage and likely to impact on policy making in the medium to long term rather than delivering immediate solutions.
- Many aspects of obesity-related research are limited by methodological problems. These include the difficulty of accurately measuring body composition, energy balance, dietary intake and physical activity in humans. Advances in technology and improved design of experiments and clinical trials have the potential to address some of these problems. Researchers need to continue to develop innovative methods in these areas to underpin advances in obesity research.
- Ongoing research is helping to identify mechanisms to manage and treat obesity more effectively, either by improving diet, by increasing physical activity, or by using medicines. This research needs to continue. Public health policy is increasingly considering the impact of wider environmental factors such as lifestyle and the built environment. Research in this area is poorly developed and needs further support.
- Strategies for managing obesity must have a proven clinical utility before they are incorporated into policy. Funding is needed to develop and evaluate innovative schemes for the prevention and treatment of obesity at national and local levels.

2 Introduction

Obesity can be defined as an excess of body fat that imparts a health risk. Dietary and lifestyle changes over the last three decades have resulted in an obesity epidemic in much of the developed world. The challenge to the scientific community is to identify the causes of obesity and develop more effective treatments, whilst curtailing its spread through preventative public health measures.

In 2004 the Department of Health published its White Paper *Choosing Health* with the promise of launching a cross-government campaign to raise awareness of a number of health issues (Department of Health 2004). This White Paper included obesity-related health risks and the steps people can take, through diet and exercise, to prevent these risks. Government policy is focussing

on childhood obesity with a national target to halt, by 2010, the year-on-year increase in obesity among children under the age of eleven, in the context of a broader strategy to tackle obesity in the population as a whole.

The increase in obesity and its impact on the nation's health is an issue of great concern to health professionals, policy makers and the public. On 19 October 2005 the Royal Society held a policy seminar in London on the scientific understanding of obesity. The meeting brought together over 80 scientists and policy makers to discuss the role of science in these important areas of public health. This provided an opportunity for them to identify areas where science can help develop future Government health policy and to summarise the key scientific issues that need to be resolved.

This report summarises the key issues and challenges that emerged from the meeting. It is not necessarily an expression of the views of the Royal Society. The meeting programme can be found in the appendix and a list of participants is available on request from science.advice@royalsoc.ac.uk.

3 Scientific understanding of obesity

3.1 Obesity indicators

The most common statistical indicator of obesity is the Body Mass Index (BMI) which is based on a height to weight ratio. A person with a BMI over 25 kg/m² is considered overweight and a BMI over 30 kg/m² is considered obese. A further threshold at 40 kg/m² is identified as morbidly obese. However, participants at the seminar highlighted that the BMI-based definition of obesity fails to distinguish between a number of important parameters such as percentage body fat and the distinction between muscle and fat. A number of other methods exist that take those parameters into account. Furthermore, the use of a single value to define obesity means that a small shift in the population's BMI will increase the number of people that are obese, but who are not necessarily at risk.

3.2 The cost and effects of obesity

An estimated six percent of all deaths in the UK are attributable directly to obesity. And being obese raises the risk of developing other conditions such as type II diabetes (greater than 10 times more likely), some cancers (twice as likely), cardiovascular disease (twice as likely), stroke and osteoarthritis (Department of Health 2004). As well as raising considerable health and welfare problems for those affected, obesity also raises serious economic issues. The cost to the UK of treating obesity and being overweight, including related chronic diseases and indirect costs such as loss of earnings due to sickness and premature mortality, is estimated to be £7 billion per year (National Audit Office 2001; House of Commons Health Select Committee 2004).

Participants at the seminar were divided over the most effective way to manage the obesity epidemic. One option is to focus on the disorder's many different causes and to try to prevent obesity from developing in the first place by promoting a healthy diet and physical activity. Other options include improving adherence to diet and exercise interventions and using drugs and surgery to treat people who are already obese.

Participants felt that the public and clinicians commonly see obesity as a problem of willpower. However, they argued that instead it should be viewed as a population-wide problem of coping inadequately with recent changes in the environment, and must be addressed through public

health measures or, in the case of severe obesity, a condition that requires clinical intervention. Participants agreed that there should be 'a war on obesity, not the obese'.

3.3 Control of appetite

Humans have evolved to seek out food, eat in times of plenty, and store energy for times of food scarcity. Ready access to convenience food, restaurants and a plentiful food supply has made this process easier. By better understanding the science of appetite control – at the genetic, physiological and behavioural levels – we can begin to understand how these systems are altered in the obese and how to modify them in order to provide effective treatments and advice.

3.3.1 Genetic control of appetite

A person's genetic makeup can influence whether they become obese or not. Studies of twins and adoptees (including adopted twins) have shown that heritable factors play a role.

Although rare, sometimes a mutation in a single gene can lead to obesity. This can cause disorders of appetite control, and in some cases the condition can be treated successfully. A case study of eight severely obese children was presented. All carried an abnormal version of the gene for leptin (a hormone involved in the regulation of food intake) and were leptin deficient. Following treatment with leptin the children were no longer obese.

Single mutations in other genes, including those for pro-opiomelanocortin (POMC) and melanocortin 4 receptor (MCR4), can also lead to obesity and their discovery is yielding useful insights into the mechanisms underlying the condition. Five percent of severely obese children in the UK have mutations in the MC4R gene. These mutations are the sole cause of their obesity.

Subtle variations in a gene (or genes) may also contribute to more common forms of obesity and to other complex disorders, such as type II diabetes. However, teasing apart the genetic and environmental factors behind obesity and its related disorders remains a formidable scientific challenge. Techniques such as meta-analysis of genetic association studies may be needed to demonstrate a link between a particular polymorphism in an 'obesity gene' and protection from common obesity.

3.3.2 Physiological control of appetite

Over the last 20 years, 114 products for obesity have been developed. Only four of these have been marketed, with just two licensed for use in the UK at present for the treatment of obesity: sibutramine and orlistat. Sibutramine works on the central nervous system to repress appetite. Orlistat inhibits gastric and pancreatic lipase to block fat absorption. It was suggested that both of these drugs produce relatively small reductions in weight and can cause side effects. A number of other drugs are currently in development. However, drugs that suppress appetite by targeting specific gut hormones are an attractive therapeutic option that may be more effective and cause fewer side effects.

Under normal circumstances, the gut sends out neural and hormonal signals triggering the feeling of fullness (satiety) to control appetite. Hormones that regulate appetite include the hormone causing hunger (ghrelin), which is found in the stomach, and hormones causing satiety (peptide YY (PYY), glucagon-like peptide (GLP1) and oxyntomodulin), which are found in the large and small

intestine. The latter may well form the basis of appetite-limiting drugs and many participants felt that these were likely to be better than other existing obesity treatments.

3.4 Foetal origins, maternal health and the development of adult characteristics

Maternal nutrition can influence health in later life, and many chronic obesity-related conditions may have their origins in foetal and infant development. Studies in the UK, Finland and many other countries have shown that low birth weight is linked to death from coronary heart disease, hypertension, impaired glucose tolerance and type II diabetes.

If the diet of a pregnant woman is nutritionally poor, her baby may be born small. This may be advantageous to the child in a lean environment, but highly damaging to a small baby in an affluent environment as they may put on weight rapidly. Some researchers think that the pathway of growth that leads to obesity related chronic disease in later life begins with small body size at birth. This is followed by low weight gain during infancy. Thereafter rapid increase in body mass index further increases the risk of disease in later life.

3.5 Public health

Obesity in children is on the increase (Department of Health 2003; Department of Health 2004b). By 2010, it is predicted that one fifth of all children under the age of eleven will be obese. The rate is highest among children with two obese or overweight parents, but is also increased among children with one obese or overweight parent (Department of Health 2005). Children living in inner cities and deprived areas also have an increased risk of obesity. Race does not appear to be an important factor in determining prevalence of the condition (Department of Health 2005). However, in some studies race has been shown to affect where fat is stored within the body which may have health implications.

Adult obesity is also a serious problem. In 2003, around one in four adults were obese and this is predicted to rise (Department of Health 2004b). Being obese is currently estimated to shorten life expectancy of the UK population by around 2.6 years. If the current trend in the rise of obesity continues, by 2051, being obese is predicted to shorten life expectancy by around 5.3 years (Department of Health 2004).

The 2004 White Paper *Choosing Health* included the Government's obesity Public Service Agreement (PSA) to halt the year-on-year increase in obesity among children under eleven by 2010. This is a cross-government target together with the Department for Education and Skills and the Department of Culture, Media and Sport and delivery depends on a concerted, joined-up effort across Government and at a local level. *Choosing Health* was based on the principles needed to empower adults to make informed choices about their own health, but the Government believes that for children, we can and should be more prescriptive.

3.5.1 Diet advice and public health

The rise in obesity is linked to a change in our eating habits and many factors are involved. 'Fast foods' high in sugar, salt and fat, have become more popular. Many foods are now more 'energy dense', meaning that people can eat the same amount of food but derive more energy from it. Poor eating patterns, larger portion sizes, reliance on convenience foods and a decrease in breastfeeding are also thought to contribute (House of Commons Health Select Committee 2004).

The Government, through the Department of Health, is trying to improve children's diets through a number of initiatives. These include: the Healthy Start initiative to provide children in low income groups with a greater choice of fresh fruit and vegetables; the School Fruit and Vegetable Scheme to increase fruit and vegetable consumption by providing all four to six year olds with a free piece of fruit or vegetable every day; helping undernourished mothers (see section 3.4); and promoting breastfeeding. Controlling the way in which food and sugary drinks are promoted to children (eg via the media) may also improve diet. With this in mind, the Government is currently in discussion with the food industry to try to increase the availability of, and access to, healthier foods.

3.5.2 Diet and nutrition research

Many delegates commented on the problems of finding a consistent scientific message to explain the link between particular foods and obesity. However, there is an increasing interest in food habits as well as individual nutrients. Energy-dense diets, sugar-rich drinks and large portions are all risk factors for over-consumption (World Health Organization 2003). Research is ongoing into the role of diet composition in the cause and management of obesity. However, more research is needed in this area, including the effect of the ratio of carbohydrate, protein and fat in the diet.

Methodological problems contribute to the difficulty of explaining the link between particular foods and obesity, for example, the difficulty in setting up properly controlled experiments. In the classic double-blind trial, participants and experimenters do not know which participants are receiving which treatments. This is very hard to do in a food-related trial. The process of obtaining informed consent and baseline screening may also act as an intervention in itself, resulting in people adjusting their eating habits. New methods are needed to obtain reliable and statistically significant data. This could include more robust cross-sectional associations examining the relationship between obesity and contributing factors such as diet and exercise at a given time, and prospective studies examining the effectiveness of an intervention over time.

Other factors also hamper dietary research. Energy intake is very difficult to measure reliably in people. Information received from self-reported food habits can be unreliable – most people underestimate the amount they eat by around 25%. Altogether, this makes it difficult to judge the extent to which epidemiological observations reflect true effects, artefacts or spurious associations. It is hard to separate out the effects of other dietary components, physical activity and other lifestyle traits.

3.5.3 Physical activity

We are eating more calories but burning fewer of them. More car journeys, less sports and unsupervised play in schools, and the rise in sedentary pastimes are all thought to contribute. The Department of Health's *Physical Activity Plan*, published in March 2005, includes two further PSAs aimed at increasing children's physical activity (Department of Health 2005b). Furthermore, attention is now being paid to the influence of the social and built environments and how they affect levels of physical activity, although more research is needed in these areas in order to direct policy.

Participants debated the growing body of evidence linking weight gain and lack of activity. Obesity, it was noted, has been linked to a decline in leisure time physical activity but less is known about incidental activity such as walking, cycling and general movement throughout the day. The best way to achieve weight loss is through dietary restriction *and* exercise. Physical activity can also

improve the health of obese people by reducing the risk of related disorders such as coronary heart disease and type II diabetes.

It is hoped that in the future, research into physical activity will provide the basis for evidence-based policy. Rigorously designed experiments could yield useful scientific information that could help inform policy on obesity-related issues. At present however, the field is in its infancy and there is little scientific information available and few rigorous studies planned to support evidence-based policy. Several systematic reviews of existing evidence-based policy have been undertaken (Health Development Agency 2004) but there have been few UK-based studies on physical activity and weight loss, and even fewer on physical activity and obesity prevention. However, there is some, albeit as yet rather weak, evidence indicating links between physical activity and prevention of obesity.

As in the case of diet and nutrition research (see 3.5.2), the importance of methodological and study design was highlighted. Improved methods of quantifying physical activity, particularly those aspects of energy expenditure that are lifestyle related, are currently being developed. These include pedometry, accelerometry and global positioning sensors to provide more precise measurement. A gap was observed between the evidence created in expensive trials, and interventions and services at a local or regional level. The results of these smaller trials may be promising but they lack the financial support to assess their effectiveness.

4 Addressing the issues

4.1 Prevention and treatment of obesity

Guidelines on the prevention, identification, assessment and management of overweight adults and children are expected to be published by the National Institute for Health and Clinical Excellence in 2007. In many cases the prevention and treatment of obesity are not seen as mutually exclusive. Lifestyle choices such as a healthy diet and more exercise can help prevent obesity and help treat those who are already overweight (see 3.5.3). Despite the overlap in treatment and prevention, the following sections attempt to summarise the current policies on obesity treatment and prevention and indicate where science may play a role in the future.

4.1.1 Prevention of obesity

Obesity prevention is a major public health goal and a current focus of Government policy. Measures include: improving school meal quality, promoting physical activity in schools, offering health advice to adults and raising public awareness to prevent both weight gain in lean people and further weight gain in the obese. The prevention of weight regain after successful weight loss is also an issue. Prevention strategies should be based on the best available evidence and studies should be commissioned if there is a gap in knowledge.

4.1.2 Treatment of obesity

Obesity treatments can be divided into three categories:

- Behavioural interventions such as dietary changes and exercise
- Medical treatments such as appetite suppressing drugs
- Surgical interventions (bariatric surgery) for severely obese patients when other treatments have failed

The cornerstone of effective weight loss is dietary change with exercise. Many trials have assessed the effectiveness of weight-loss drugs, but few have assessed the effects of behavioural intervention. This omission needs to be redressed.

A greater understanding of obesity-related genetics, the role of the environment, and the physiological and behavioural basis of appetite control (as discussed in section 3.3) is expected to aid in improving the advice given to patients and the development of new drug therapies. Bariatric surgery for morbid obesity falls into two main categories: restrictive surgery (which reduces the stomach size) or malabsorptive surgery (which reduces the absorption capacity of the gut). Surgical intervention was discussed and generally supported by the speakers, but there was agreement that it is under-resourced in the UK. However, it is important that the public recognise that they need to adjust both diet and exercise to control their weight and do not see the development of anti-obesity drugs or bariatric surgery as the primary treatment for obesity.

4.2 Policy making to address obesity

Policy makers need to further examine how the treatment of obese patients should be considered within the current frameworks. As new obesity treatments become available, policy makers need to consider how to make them available. Scientists and policy makers need to work together to ensure that scientific developments are at the heart of evidence-based policymaking and jointly determine where obesity-related research funding be invested.

Several policy-related needs were highlighted during the seminar, namely:

- A detailed summary is needed of the current state of obesity-related research and its implications for public health. It is hoped that this will be addressed by the Foresight obesity study (Foresight 2005). Care is needed to summarise accurately developments in the understanding of obesity and to avoid overstating the adverse consequences of obesity on human health.
- If new practices at both the national and local level are shown to be clinically useful and cost-effective then they should be incorporated into policy. The impact of new policies should be evaluated to support ongoing policy development.
- Policies should allow for individual choice, but it is permissible to be more prescriptive for children who may be unable to make an informed choice for themselves.
- Policy makers should make decisions on prevention and treatment strategies supported by scientific evidence. These strategies should be available across the UK population both in terms of access to services and information.

Legislation can be used to help implement policy, though the necessity of legislation has to be considered in the context of individual choice and the Government's priority to reduce the amount of legislation. An example of this is food advertising to children where the Government sees the introduction of legislation to restrict advertising to children as a 'last resort' (also see 4.2.1).

4.2.1 Evidence-based policy and evaluation of practice

The results of obesity-related scientific research and clinical trials should inform the development of related policies. Equally, the process and outcome of new policies must be fully evaluated.

A good example of this evidence-based policy development is the Food Standards Agency's action plan on the promotion of food to children (Food Standards Agency 2004). Scientific evidence suggested that children's diets were not meeting desirable nutritional standards, and there was

public concern that food advertisements were steering children towards less healthy options. This led to further research on how advertising affects food choice (Office of Communications 2004), the results of which may be used to underpin regulatory action by the Office of Communications (OFCOM). The outcomes of any action need to be fully evaluated.

The meeting highlighted the need to examine the range of evidence used by the Government to develop policy. For example, the UK as a whole does not have a repeated ongoing cross-sectional study to look at changes in the UK population demographics, such as height, weight or sufficiently comprehensive measures of physical activity. This could prove a powerful tool in obesity research and could aid future policy making.

Better methods to evaluate policy are needed, together with funding at a local level to develop and evaluate innovative schemes for obesity management. For example, when evaluating policies which promote a healthy diet to children we must evaluate not only the availability and uptake of healthy food, but the overall outcome on diet and obesity levels. Policy development will benefit from a broad range of information, including academic research and the best surveillance data.

It was agreed that scientists must uphold the principle that policy should be based on high quality evidence. As outlined in sections 3.5.2 and 3.5.3, the methodological difficulties in some areas of obesity research mean that evidence is less complete than it might be. In recognition of the urgency of the obesity epidemic, scientists and policy makers should accept that policies must be developed based on the best evidence available, whilst striving to improve the evidence base. It is also vital that evidence obtained from the evaluation of current policies is incorporated into clinical practice.

5 Conclusions and recommendations

The following is a summary of the conclusions and recommendations arising from the meeting.

- Dietary and lifestyle changes over the last three decades have led to an obesity epidemic in the UK. Obesity is a serious problem that can cause illness and death; both directly and through related chronic conditions such as type II diabetes and coronary heart disease. **This is an important problem that must continue to be addressed by Government and policy makers at the highest level.**
- The scientific understanding of obesity is growing rapidly and is yielding many discoveries that may be useful in the management of obesity. However, gaps still exist in our knowledge and **scientists and funding bodies should work with policy makers to commission further research and studies.** Research is at an early stage in many areas and it is unlikely that there will be a single route to solve the obesity epidemic. Research is needed in all areas such as: the genetic, molecular, physiological, behavioural and psychological aspects of obesity; epidemiological studies of maternal, foetal and infant nutrition; methods of improving diet and increasing physical activity and, where appropriate, using drugs to treat obesity.
- Advances in technology and improvements in the design of studies have the potential to address some of the methodological problems associated with obesity research. **Innovative approaches to research on obesity are required**, particularly in areas such as accurate assessment of energy balance, food intake, physical activity and body composition.
- Policy making should be based on the best available evidence including the results of obesity-related scientific research and human studies. It would be useful to **summarise in detail the current state of obesity-related research and its implications for public health.** It is

hoped that this will be addressed by the ongoing Foresight obesity study (Foresight 2005). Care is needed to summarise accurately developments in the understanding of obesity and to avoid overstating the adverse consequences of obesity on human health.

- Scientists and policy makers need to work together to ensure that **scientific developments are at the heart of evidence-based policymaking** and engage with the public to ensure that policies respect individual choice and maximise the likelihood of them being adopted.
- Strategies for managing obesity must have a proven benefit or clinical utility before they are incorporated into policy. Evidence from the clinic where treatments are piloted needs to be assessed, and when justified, included in policy development. **Funding is needed at the national and local levels not only to develop new schemes but also to evaluate the benefit of existing schemes for obesity management.**
- Different evidence-based public health approaches complement each other. The development of strategies for the treatment and prevention of obesity need to be considered in the wider context, such as examining the evidence around altering behaviour as well as traditional drug-based treatments. **Government needs to commission and resource innovative projects to encompass the social and environmental, as well as scientific aspects of obesity, to tackle the rising levels of obesity within a framework that promotes healthy living.**

6 References

Further reading and specific references identified in the text.

Department of Health (2003). *Health Survey for England 2002: The health of children and young people*. Stationery Office: London

Department of Health (2004). *Choosing health: making healthier choices easier*. Government White Paper. Stationery Office: Norwich

Department of Health (2004b) *Health Survey for England 2003*. Stationery Office: London

Department of Health (2004c). *At least five a week*. Stationery Office: London

Department of Health (2005). *Obesity among children under 11. Report of the Joint Health Survey Unit*. Department of Health: London

Department of Health (2005b). *Choosing activity: a physical activity plan*. Department of Health: London

Food Standards Agency (2004). *Action plan on food promotion and children's diets*. Food Standards Agency: London

Foresight (2005). *Foresight obesity project*
Available online at www.foresight.gov.uk/obesity/obesity.htm

Health Development Agency (2004). *Interventions on obesity- better health for children and young people* (Health Development Agency Briefing number 3). Health Development Agency: London

House of Commons Health Select Committee (2004). *Third report of Session 2003-04, Obesity HC2301*. Stationery Office: London

National Audit Office (2001). *Tackling obesity in England*. Stationery Office: London

Office of Communications (2004). *Child obesity - food advertising in context*.
Available online at www.ofcom.org.uk/research/tv/reports/food_ads/report.pdf

World Health Organization (2003). *Diet, nutrition and the prevention of chronic diseases*. World Health Organization: Geneva

Annex Programme from the day

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| 8.45 | <p>Early Bird lecture Professor Jeffrey Friedman, <i>Rockefeller University, New York</i> Leptin and the biologic basis of obesity</p> |
| 9.20 | Coffee and registration |
| 9.45 | <p>Welcome and Introduction Professor David Read FRS, <i>Vice President and Biological Secretary, Royal Society</i></p> |
| | Session one Chair – Professor David Read FRS |
| 09.50 | <p>Tabitha Jay, <i>Department of Health</i> Obesity- A Government priority</p> |
| 10.20 | <p>Professor David Barker FRS CBE, <i>University of Southampton</i> The developmental basis of obesity</p> |
| 10.55 | <p>Professor Stephen O’Rahilly FRS, <i>University of Cambridge</i> The genetic basis of obesity</p> |
| 11.30 | Coffee |
| | Session two Chair – Professor Stephen O’Rahilly FRS |
| 11.50 | <p>Professor Stephen Bloom, <i>Imperial College London</i> Mechanisms of satiety</p> |
| 12.25 | <p>Dr Nick Wareham, <i>University of Cambridge</i> Gene-lifestyle interactions on obesity risk</p> |
| 13.00 | Lunch |
| | Session three Chair – Sir John Krebs FRS |
| 14.00 | <p>Professor Ken Fox, <i>University of Bristol</i> Physical activity and public health</p> |
| 14.35 | <p>Dr Susan Jebb, <i>MRC Human Nutrition Research Centre</i> Food, obesity and public health</p> |
| 15.00 | Tea |
| 15.15 | <p>Panel discussion Chair – Professor David Read FRS Panel Sir John Krebs FRS, <i>University of Oxford</i> Dr Susan Jebb, <i>MRC Human Nutrition Research Centre</i> Professor Stephen O’Rahilly FRS, <i>University of Cambridge</i></p> |
| 16.15 | <p>Summary Sir Patrick Bateson FRS, <i>University of Cambridge</i></p> |
| 16.30 | Close |