# A review of the economic analysis of obesity

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There are indications that the treatment costs arising from obesity are significant. However, the cost-of-illness studies undertaken to date also highlight two other important points. First, the cost of treatment is sensitive to the body mass index (BMI) cut-off used. Given that there is no definitive definition of obesity as based on BMI, a range of costs reflecting differing BMI cut-offs may be more appropriate than the use of a single figure. Second, the costs are, not surprisingly, also sensitive to the defined associated diseases. Again there is little agreement on these and also little information on the relative risks of attributable diseases arising from obesity. The calculations of the cost-of-illness arising from the treatment of obesity, and its associated conditions must, therefore, remain indicative rather than authoritative.



Obesity is a common health problem which is a recognised disease in its own right, but also a major risk factor for a number of other diseases, including cardiovascular disease, non-insulin dependent diabetes, certain cancers, gallbladder disease and hypertension. Normally measured through the use of the body mass index (BMI), obesity has been classified as a BMI above 30 kg/m$^2$. The risk of associated disease increases with BMI. There is also evidence that obesity decreases longevity[1,2].

The number of obese individuals in the UK has also been increasing over the past 10–15 years. Recent data have estimated the percentage of individuals who are obese as 13% for men and 16% for women in the UK, although for overweight and obesity, individuals with a BMI above 25 kg/m$^2$, the percentages increase to 57% and 48%, respectively[3,4]. The impact of the disease is, therefore, liable to increase in the future with a consequent rise in the resources drawn to its treatment. Given the prevalence of the disease, it is perhaps surprising that little analysis of the resource consequences have been undertaken. The aim of this paper is to undertake a review of the economic studies applied to obesity. As we shall discover, there is a very thin literature on this subject matter and most of this is not, strictly speaking, concerned with economic evaluation. Prior to discussing the specific literature it is, then, worthwhile defining some of the different types of economic analysis.

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## Types of economic analysis

It is increasingly obvious that resources devoted to health care are scarce and limited. While the encouragement of a more rational use of health resources should be welcomed by all, there are concerns that quality might be sacrificed in order to control cost. Yet it is precisely because economic analysis is based on an assessment of both costs and benefits that it is a tool that allows the relative merits of alternative resource usage to be appropriately considered. Thus, economic efficiency is not the same as cost cutting. In many cases, the key issue of economic evaluation is whether additional benefits justify the additional costs. Indeed, when the overall level of resources is limited, cost and benefit are the opposite sides of the same coin. If the health care budget is fixed, more costs in some parts of the health-care system mean that benefits are forgone elsewhere. Efficiency is then determined by the relative costs and benefits derived from different allocations.

Economic evaluation of health care is the generic term referring to the various methods used to make the costs and benefits associated with any change in health service delivery explicit. These methods consider the costs of health care interventions and their consequences. If a new health care technology is introduced, both the relative benefits and the relative costs of that technology are calibrated against existing treatment. If the benefits to be gained from the new intervention were no greater than those already achieved by the existing treatment, yet the costs were higher, economic evaluation would reject the introduction of the product on the grounds of inefficiency. Conversely, if the benefits were at least as good as those achieved by existing health technology and the costs were lower, economic evaluation would advocate the introduction of the new intervention on efficiency grounds. Where the benefits and the costs of the new technology are both higher or both lower, the argument for introduction on efficiency grounds depends on the degree and rate at which health benefits.

Economic evaluation provides a means to adjudicate between the relative costs and benefits arising from competing health care technologies. However, a form of analysis which, while not an economic analysis but nevertheless does involve quantification of resource use, is the 'burden of illness' or 'cost of illness' method.

Burden of illness or cost of illness studies are not particularly common in the disease area of obesity. They are a separate form of analysis, not to be confused with economic evaluation, which quantifies the existing burden imposed on society, or cost to society, of a given disease. They do not consider the relative costs and consequences derived from new treatment technologies. **Burden of illness** and **cost of illness** studies estimate the absolute amount of resources used in treating a disease over

a given period. They are not concerned with evaluating the resource impact of a new form of treatment, but give an indication of the full cost (measured in terms of mortality and morbidity as well as treatment resource costs) imposed by a disease on society. These studies indicate the current total cost of treating a particular disease as part of their analysis. They may be prevalence or incidence based.

There are a number of specific forms of **economic evaluation** which differ in the extent to which they measure and value the consequences. Otherwise the analysis is much the same: each formulation attempts to consider the cost of achieving particular consequences. All economic evaluations consider costs. All are based on the comparison of different treatment programmes. Different techniques address different questions. The question to be addressed determines the technique to be employed. The different approaches are defined as follows.

## *Cost-minimisation analysis*

All forms of economic evaluation consider the costs arising from the use of resources to achieve therapeutic outcomes. Only one form of analysis, **cost-minimisation analysis**, considers costs alone. It is relevant, therefore, only when the medical effects of two alternative therapies are identical, such as in the substitution of an equivalent generic product for a branded one. If the interventions do not have identical outputs in terms of health gain, then cost-minimisation is not a form of economic evaluation. Rather it is reduced to a simple analysis of the costs of alternative treatments. Unfortunately, all too often, outcomes are ignored and costs alone are minimised, as in a number of so-called 'efficiency saving' exercises which are, in effect, budgetary control measures. This may be good accounting practice, it is not good economic practice.

## *Cost-effectiveness analysis*

Few interventions reduce costs overall and usually the assessment of an intervention compares the resource input with the improvements in health obtained. Another form of analysis, **cost-effectiveness analysis**, assesses the consequences of treatment intervention in the most convenient natural units, normally some physical measure of the health care output associated with treatment. Common measures of effects relate to physiological measures taken from clinical trial data, for example changes in BMI could be used. It is important, however, to

consider the validity of the units of effect used, as they may not correlate well with health gain.

Alternative common measures of effectiveness are the number of 'symptom-free' or 'disease-free' days, if morbidity is influenced by treatment. If mortality is affected by treatment, changes in survival probabilities (normally converted through the use of life tables to changes in life expectancy or, even more commonly, life-years gained) may be used as a measure of effectiveness.

## *Cost-utility analysis*

In many situations, it is important to consider also the preferences of individuals towards different forms of intervention. The preferences of individuals reflect the gain in welfare or satisfaction or, to use a more unfashionable term, the utility arising from the treatment. **Cost-utility analysis** attempts to do so by attaching preference values to the outputs associated with treatment. While cost-utility analysis does not fully value the health gains associated with interventions, in that it stops short of attaching monetary valuation to outcomes, it does move in the direction of a fuller definition of the benefits derived from health care by incorporating information on preferences.

The preference information is used as a weighting of the physical output measure which forms the basis of the cost-effectiveness analysis. The most common form of cost-utility analysis to date has been based on the measure of outcome from health care in terms of the quality of the life-years gained. Here, preference valuations on different levels of quality of life are used to weight changes in survival probabilities associated with interventions. Results are then presented in terms of cost per quality adjusted life-year (QALY) gained from alternative treatments.

Quality of life is also important for those chronic conditions where therapy adds life to years rather than years to life. Evaluation assessing the benefits in quality-adjusted life-years are called cost-utility analyses. As cost-utility analysis does not consider the full value of the intervention it is again concerned with productive efficiency. Although, as the health gain is measured in commensurate units, QALYs, there is scope for comparisons across different forms of intervention.

## *Cost-benefit analysis*

There have been few comprehensive cost-benefit analyses where attempts are made to assess all the costs and benefits in monetary

terms. The advantage of **cost-benefit analysis** is that there is direct measurement of the valuation individuals themselves attach to the health benefit, and both costs and benefits are measured by a commensurate instrument – money. This allows direct comparison across all forms of intervention and provides information on the most highly valued uses of health care resources. Thus, direct information is made available to allow the optimal mix of health outputs to be provided. Not surprisingly, however, it is particularly difficult to assess health benefits in monetary terms. The general approach is to estimate the value in monetary terms of the full impact of an intervention. This is normally addressed through trying to elicit the willingness to pay for a change in health state arising from a particular treatment or intervention.

Each form of evaluation adopts a similar approach. Cost-benefit analysis compares the opportunity costs associated with achieving treatment outcomes with a quantitative measure of the value of the benefits achieved. Cost-effectiveness analysis and cost-utility analysis each attempts to quantify the total resource cost and the total outcome (weighted outcome in the case of cost-utility analysis) associated with a pre-specified intervention and compare these with the total cost and the total outcome achieved from the next best use of resources. Cost-benefit analysis requires no comparator intervention, while both cost-effectiveness and cost-utility analysis do.

In order to facilitate such comparison, cost-effectiveness and cost-utility analysis are normally presented as a ratio with the total cost divided by the total outcome achieved to give a cost per unit of outcome. The lowest cost per unit of outcome is the most productively efficient intervention. Subsequently, the cost per life year gained is calculated by dividing the total costs arising from an intervention by the total calculated life years gained from an intervention. In comparing two, or more, interventions, the one achieving the lowest cost per life year saved is the most productively efficient allowing a given budget to buy the greatest level of output.

## Economic studies of obesity

As noted above, there have been very few economic studies in this disease area. Possibly the most comprehensive coverage to date has been the reportage of a seminar in a special edition of *PharmacoEconomics* (Vol. 5, Suppl., 1994) and the reporting of a set of conference papers in a supplement to the *International Journal of Obesity* (Vol. 19, Suppl. 6, 1995). Like most other studies, these papers mainly were concerned with the cost of illness rather than comparisons of the economic efficiency of

different interventions to control obesity. Most of the studies concentrated on the direct costs imposed on the health system arising from the current prevalence and treatment of the disease. The simplest manner in which this could be undertaken is to estimate the treatment prevalence of obesity for specified treatments in a specific health care system and then attach unit costs of the individual treatments to gain an estimate of the aggregate cost of obesity. This would, however, certainly underestimate the costs borne by health care systems, as it is well established that obesity leads to an increased risk of co-morbidity in other diseases. To estimate the cost of direct treatment of obesity, the cost of treating these co-morbidities as attributable to obesity must be estimated. This has been approached in a number of manners.

The simplest approach is that adopted by Colditz[5] in a US study. Colditz first identified the relevant co-morbidities as cardiovascular disease (CVD), gallbladder disease and cholcystectomy, colonic and postmenopausal breast cancer, hypertension and non-insulin dependent diabetes. The cost of treatment of each of these co-morbidities attributable to obesity was calculated by assuming that a given amount of the disease is diagnosed amongst obese individuals of which a certain proportion is attributable to obesity. He then used estimates of the aggregate costs of treating the identified co-morbidities by applying this proportion to an estimate of the cost of treating co-morbid diseases in the attributable population. For example, Colditz[5] assumes 27% of CVD is diagnosed in obese individuals and that, among the obese, 70% of CVD is attributable to obesity. Thus 19% ($0.27 \times 0.70$) of the estimated aggregate cost of treating CVD in the US can be attributed to the disease obesity. Overall, the costs attributed to obesity were $22.2 billion arising from CVD, $2.4 billion for gallbladder disease, $1.9 billion for colonic and breast cancer, $1.5 billion for hypertension and $11.3 billion for non-insulin dependent diabetes. This gives an estimate of $39.3 billion as the cost of treating obesity in the US in 1986. Extending the definition of co-morbidities somewhat, for example by including musculoskeletal diseases, and up-dating these earlier calculations, Wolf and Colditz[6] revised the estimate of the direct cost of treating obesity in the US to be $45.8 billion in 1990. To put this in perspective, this amounted to approximately 6% of the total expenditure on health care in the US in 1990.

Using a similar approach, West[7] estimated the treatment cost arising from obesity in the UK to be around £195 million, of which the cost of treating obesity directly was around 15% (£29.35 million). He estimated that a further £85.5 million was spent through the purchase of dietary products.

More rigorous calculations of the attributable costs arising from treating co-morbidities are given in Levy *et al.*[8], Segal *et al.*[9], and

Seidell[10]. These calculations are similar to the calculations used by epidemiologists to estimate attributable risk, which is defined as the proportionate excess risk of disease that is associated with exposure to a risk factor. Using obesity as the risk factor, population attributable fractions (PAFs) were first calculated by Segal *et al*[9]. These are the product of the relative risk (rr) and the prevalence risk factor (P):

$$PAF = P(rr-1)/[P(rr-1) + 1)]$$

This is precisely the same expression as that calculated by Levin[11] for attributable risk. Given information on the relative risk of disease in obese patients, the PAF can be calculated to estimate direct cost of treating obesity; this is based on the excess population in the co-morbid conditions attributed to have the condition as a result of obesity and then the proportion of costs of treating these co-morbidities that ought to be attributed to these conditions. Segal *et al.*[9] used the same information on co-morbidities as reported in Colditz[5] and estimated the total cost of treating obesity in Australia in 1989 as $A395 million. Of this, approximately 7% ($A28.7 million) are costs which are incurred as a result of treating obesity itself, with the vast majority of costs resulting from the treatment of co-morbidity. As in the Colditz studies, hypertension and CVD were the most significant co-morbidities in terms of cost.

Levy *et al.*[8] used a much more extensive range of co-morbidities but applied the same methodology based on attributable risk. They estimated that the direct cost of treating obesity in France in 1990 was approximately FFr12 billion or approximately 2% of the French health care costs. This was based on information relating to relative risks arising from a BMI $>27\,kg/m^2$. Their study showed that, if the calculations were based on a BMI $>30\,kg/m^2$, the costs fell to FFr5.8 billion, highlighting that the estimated cost of treatment is sensitive to the BMI cut-off used.

Seidell[10] used a similar methodology to report the direct costs of treating overweight and obese patients for their condition and associated conditions in The Netherlands. Overweight is defined as being present if individuals have a BMI $>25\,kg/m^2$ but $<30\,kg/m^2$, and obesity is defined as a BMI $>30\,kg/m^2$. It was estimated that the cost of treatment of both overweight and obese individuals amounted to around 4% of the total Dutch health care costs; obesity itself accounts for about 1% of the total costs of health care. From this, and the studies by Levy *et al.*[8] and Segal *et al.*[9], Seidell estimated that, depending on the definition of obesity, the cost impact of treating this condition and its attributable co-morbidities is between 1% and 5% of total health care costs[10].

Using a different methodology based on a regression model, Hakkinen[12] estimated the excess use of health care in Finland due to

obesity. A latent variable model was constructed to assess the impact of obesity on health and, through this, on health care utilisation. The model estimated that if all Finns could be reduced to normal body weight, i.e. a BMI $<25\,kg/m^2$, then 190 million Finnish marks could be saved from the health care budget; cessation of smoking by all Finns was estimated to save 150 million Finnish marks in the same model.

Concentrating on a specific medical event, Galtier-Dereure *et al.*[13] found that, during pregnancy, obesity caused many more complications than in a control group. Moreover, the mean duration of hospitalisation and cost were significantly correlated with maternal weight. The results were based on a retrospective study of 112 deliveries from 89 overweight and obese women during 1980–1993 and compared with a control group of 54 normal weight women over the same period. They found, for example, that 66% of massively obese (BMI $<35\,kg/m^2$), 36% of obese (BMI 30–35 $kg/m^2$) and 33% of overweight (BMI 25–30 $kg/m^2$) pregnant women were hospitalised compared with 9% in the control group. Overall cost was 3 times higher in the massively obese than in the normal weight women. Moreover, about two-thirds of infants born to obese mothers required care in a paediatric unit.

As well as the direct costs arising from the treatment of obesity, a number of studies have calculated the indirect costs of the disease. The direct costs may be defined as any costs arising as a direct result of treatment intervention. These are commonly restricted to health care costs but could include, for example, costs incurred by patients themselves; hence slimming or dietary amendment costs incurred by the individual are direct costs. Indirect costs are the costs which impose further effects, arising from the presence of a disease, on sectors other than the health care sector. The most obvious example is the cost resulting from obesity when individuals have to take time off work as a result of the disease. This results in a loss of productive output and is a cost to society. This is, of course, a restricted notion of indirect cost. There may be considerable social and psychological costs arising from obesity which are recognised but never quantified (for a fuller discussion see Gorstein and Grosse[14] and Hutton[15]).

Colditz[5] estimated the indirect costs arising from lost productivity to be $20 billion for the US in 1986 and $23 billion in an up-dated paper[6]. Sjostrom *et al.*[16], using survey material, estimated that the level of sickness absence was 1.4–2.4 times higher in obese patients than in normal weight individuals and the number on disability pension was 1.5–2.8 times higher. Extrapolating to the Swedish population as a whole, they estimated that 7% of total productivity loss in Sweden was obesity related. Generally, however, indirect costs are estimated to be considerably lower than the direct costs of treating obesity and associated diseases.

This limited evidence would imply that the cost of treating obesity is a major draw on resources. Whether this resource impact can be alleviated by better or more comprehensive treatment is unknown as there has been little proper economic evaluation of the treatment of obesity. Beales and Kopelmen[17] give an overview of the existing available methods of treating obesity, but note that there is little evidence on the success of the various interventions in controlling weight loss. Detailed costing information on the various interventions is also not readily available. Thus, it is not surprising that there are extremely few true economic evaluations of the treatment of obesity.

Dahms *et al.*[18] conducted a study of the cost-effectiveness of behavioural therapy (consisting of group discussions led by a dietician), placebo and two anorectic drug regimens in a population of 120 obese patients over a 14 week period. One of the problems in establishing effectiveness in obesity arises from compliance: indeed, in this particular study, only 33 patients completed the programme. All treatment groups lost similar amounts of weight, and there was no significant difference between the placebo and either of the drugs (mazindol and diethylpropion). Given this and adverse effects recorded with the drug regimens, behaviour therapy was recommended to be the most cost-effective practice.

Martin *et al.*[19] compared the cost-effectiveness of medical and surgical treatment of severely obese individuals. The mean BMI for surgical patients was 49.3 kg/m$^2$ and for medical patients it was 41.2 kg/m$^2$. The study included 464 subjects who were monitored for 2–6 years over the period 1984–1991: 362 patients completed the programme. A total of 201 patients were entered into the surgical programme, Roux-en-Y gastric bypass, and 161 entered into the medical programme, weekly meetings for 1.5 years with dietary and life-style advice. Successful completion was taken to mean a loss of one-third of excess weight above ideal body weight. The economic end point was the cost per pound lost. The cost per pound lost was recorded at each follow-up point. Over the whole period, the medical programme had a marginally more cost-effective impact; however, by the sixth post-treatment year, the cost per pound lost for the medical treatment exceeded that of the surgical treatment. On this basis, the authors concluded that the surgical intervention was more cost-effective, but this may not be the correct conclusion. For example, it is unclear precisely what time period is being considered. Six years of follow-up were reported, but no explanation as to why this period had been decided on. Moreover, it is not clear that the costs had been discounted. If they had been, then over the follow-up period reported it is probable that the medical management would have been more cost-effective than the surgical intervention.

## Discussion

Given that these costs do appear to be significant in most health care systems, it is perhaps surprising that there have been so few economic evaluations of the existing treatments. For any economic evaluation, however, there has to be reliable clinical evidence of efficacy at least. Accepting the difficulties associated with measuring long term follow-up, not least the high withdrawal rates to be expected in this area, the lack of economic evaluation could reflect the low level of clinical evidence in this disease area. As reported, we have only been able to trace two such evaluations, both of which are cost-effectiveness studies. Given the impact that obesity has on an individual's perception of well being, it is perhaps also surprising that there have been no economic evaluations based on quality of life measures. We can only hope that, as we drift away from the *Health of the Nation* targets in this area, more effort will be concentrated on the effective strategies to control obesity and that the cost-effectiveness of these strategies will be considered.



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