

Economic impact of disease and injury: counting what matters

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Accepted: 19 October 2009

Cite this as: *BMJ* 2010;340:c924
doi: 10.1136/bmj.c924

Dan Chisholm and colleagues discuss how studies looking at the economic consequences of ill health might be improved

Over recent years, the number of published studies looking at the economic burden or impact of disease and injury has dramatically risen. When we searched the Library of Congress Web of Science database we found 735 papers published between 2000 and 2008 with the topic term “cost of illness”, compared with 180 over the course of the 1990s and a total of just over 200 studies before 1980.¹ The increased demand for this type of information has been fuelled by the view among many public health officials that it might influence the decision of a ministry of finance or a donor agency to release additional funds to combat a specific health problem or threat.

Although insufficient as a basis for resource allocation in health (for which information on the effectiveness of interventions is also necessary), appropriate estimation of the economic losses or costs associated with a particular disease entity or health condition can certainly contribute to or address a number of health policy questions. For example, what impact might major causes of death and disability such as malaria, stroke, or road traffic injuries—or indeed new health shocks like H1N1 pandemic influenza—have on the current or future rate of economic growth in countries? What proportion of government resources could have been directed to alternative uses in the absence of these diseases; or in their presence, how much of a household’s income is reduced by the inability to work or is used up for medical care?

However, and despite the fact that there is general agreement about the channels through which poor health can have economic effects,^{2,3} a large proportion of empirical estimates

are conceptually flawed and have little actual economic meaning. Here, therefore, we set out to highlight some of the main conceptual flaws that commissioners or users of such studies might want to look out for, as well as to provide an overview of the various estimation methods that might be best applied to different health policy questions. In doing so, we draw on a more detailed discussion of these issues in a recently published *WHO Guide to Identifying the Economic Consequences of Disease and Injury*.⁴ We hope that a more considered approach will not only make the resulting estimates more meaningful, but also enhance the comparability of study results within and between different health conditions.

Conceptual questions for economic impact studies in health

Key questions for commissioners and users of economic impact studies in health are set out in the box. These have to do with the underlying purpose and reference point of such studies, as well as their scope and perspective. Some examples of how they might be answered in relation to specific health policy questions are shown in the table.

What is the perspective?

Quantification of the economic consequences of disease or injury can be undertaken at the level of any economic entity—an individual, household, firm, or government—or at some level of aggregation across entities, most commonly the economy as a whole. Accordingly, a clear statement of the policy question to be addressed and the associated perspective of the analysis should be given. Studies aiming to assess the economy-wide or societal costs of disease or injury have a macroeconomic perspective, while those focused on households or business are microeconomic in nature. The estimation methods applicable to these two different perspectives are discussed later in this article.

What is the scope?

Economists define the economic consequences of ill-health quite broadly, arguing that people’s welfare—often called utility—is determined by their state of health, their consumption of goods and services, and the amount of leisure time they have. Ill health can influence all three components separately or jointly. For example, poor health reduces welfare simply because people feel worse, independent of any effect on consumption or leisure. However, poor health can also reduce the

SUMMARY POINTS

Demand is growing from public health professionals and policy makers for information on the economic consequences of ill health

The pathways through which poor health can affect economic activity are well established, but the empirical estimates that pervade the literature often have little economic meaning. Potential users or commissioners of economic impact studies in health ought to treat such estimates with caution or scepticism, but this requires the knowledge to judge which ones are meaningful and which ones are not

To assist them, we have developed guidance on how these studies should be undertaken, which we hope will result in fewer poor quality studies being carried out and published in the future. We outline the key features of the recommendations

Table 1 | Defining economic impact studies in health: illustrative policy questions and analytical choices

	What is the economic impact of depression on families?	What might be the economic fallout from pandemic influenza?	What is the overall economic cost to society of HIV/AIDS?
Perspective	Microeconomic (households)	Macroeconomic (societal)	Macroeconomic (societal)
Scope	Market economy losses (non-market losses like informal care excluded)	Market economy losses (gross domestic product)	Total welfare losses (including the intrinsic value of lost health)
Quantity of interest	Net impact of depression on households' opportunities to consume goods and services (other than health)	Impact of influenza on non-health components of GDP	Impact of HIV/AIDS on economic welfare (non-health components of GDP, plus leisure and health itself)
Counterfactual	No new or existing cases (prevalence-based)	No new cases of influenza strain (incidence-based)	No new or existing cases (prevalence-based)
Estimation method	Model showing how households make consumption choices over time	Simulation model capturing effects across all sectors of the economy	Economic growth model for GDP losses; if desired, monetary value of lives lost reported separately

opportunity to consume the things we derive utility or welfare from as a result of reductions in labour income or productivity, as well as savings and investment. It also requires people to incur medical and related expenses that they would not have incurred in the absence of illness, thereby reducing the ability to consume other, “non-health” goods and services that are valued (such as food, housing, or education), so this also reduces their economic welfare. Finally, ill health can reduce the availability of leisure time, for example, when individuals need to provide care or support for family members who are ill.

Concerning the consumption component, a further categorisation can be made into goods and services that are marketed and non-marketed. Marketed goods and services are those that are paid for, including the salaries of employees, health services, and financial investments, while the non-market component refers to unpaid but economically valuable goods and services such as housework, informal caregiving, or home grown produce that is not sold.

It is therefore important to be very clear about which of the three domains are to be quantified—the direct effect

of poorer health on welfare (the intrinsic value of losses in health status), the indirect effect on leisure time, and/or the indirect effect on consumption opportunities (that are not related to health, since use of health services or goods does not generate utility or welfare per se). So, for example, one economic impact study of malaria might set out to show the macroeconomic impact of this disease on the total market output or gross domestic product (GDP) of a country, whereas another might be interested in capturing the overall welfare losses for households, including non-financial effects such as a reduced ability to undertake household activities or to enjoy leisure time, as well as the value of diminished health itself.

What is the quantity of interest?

It is quite legitimate to seek to quantify any component of economic welfare, or the composite impact of all components. However, the underlying “quantity of interest” differs depending on the policy question, and it is incorrect to aggregate components that are essentially measuring different concepts. We illustrate this point with reference to the most common approach used in the literature, known as cost of illness, which divides the economic impact into direct costs (the expenses incurred because of the illness) and indirect costs (the value of lost production because of reduced working time). The cost of illness approach does not seek to quantify the direct effects of health decrements on welfare or leisure, describing them as intangible. Direct and indirect costs are summed to provide an estimate that is said to represent the overall cost the illness imposes on society, often expressed as a percentage of GDP.

Criticisms of this approach have been published,⁵⁻⁷ but the technique is still widely used and published. We do not repeat the known problems here, but focus on the problem of adding up across different components. The cost of illness method for determining indirect costs is to first estimate the time lost by people who would have been employed in the absence of death and ill health, and then multiply this value by the gross wage rate to reflect lost earnings. This calculation implies that the quantity of interest is lost market production, which explains why the resulting estimates are often expressed as a percentage of GDP, itself a measure of market production and consumption.

However, indirect costs are generally also imputed for home workers who are not in paid employment, on the grounds that comparisons of the economic costs across different diseases would be biased if only production losses of those in paid employment were included. Once this non-market production is included, the implicit quantity of interest is clearly now broader than GDP, which measures only market production and consumption. A label that we give to the value of both this market and non-market production is “social product” (to denote something broader than the concept of national product).

For direct costs, the quantity of interest cannot be GDP, because medical care and health related expenses actually form part of GDP; instead, and as argued earlier, a more appropriate quantity of interest would be the impact of disease or injury on the non-health components of GDP. Finally, adding direct costs to indirect costs results in a number that can no longer be easily interpreted in economic terms. The estimate does not represent the lost GDP—only the indirect

Box 1 | Key questions for planning an economic impact study in health

What is the perspective?

Does the study aim to assess the economic consequences of disease on a particular economic agent such as households or businesses (microeconomic level), or the aggregate impact on society as a whole (macroeconomic level)?

What is the scope?

Does the study aim to assess only losses associated with the market economy (for example, impacts on gross domestic product), or to also capture other constituent elements of overall economic welfare such as decrements in leisure or health itself?

What is the quantity of interest?

Is the focus only on direct medical costs due to ill-health? If so, the quantity of interest is the impact that this increased health expenditures has on other possible areas of market consumption or expenditure. Or is the focus on overall productivity losses? If so, the quantity of interest is the impact on the combined output of paid and unpaid workers. Or is it a combination of these (and maybe other) losses? If so, the quantity of interest is hard to define, indicating the need to report different components separately.

What is the counterfactual?

Does the comparator situation against which economic losses are to be assessed assume that (a) no new or existing mortality or morbidity from the disease occurs now or in the future (prevalence based approach) or (b) ill health from current or past exposure to the disease is present now and in the future, but there are no new cases (incident approach)?

costs involving market production represent such a loss; it is not the lost social product—only the (market and non-market) indirect costs are; and it is not the loss of non-health market and/or non-market consumption, because this would require calculating the impact of illness on non-health consumption opportunities over time.

In short, combining measurements of different types of economic consequences in this way—as cost of illness studies do—makes no sense and means that resulting numbers, however big, cannot be properly interpreted. Consequently, we emphasise the need to be precise about what is to be measured, and specifically recommend that combined estimates of the direct and indirect costs be avoided by keeping the reporting of these components separate.

What is the counterfactual?

Before turning to estimation methods, we touch on one other common pitfall relating to the specification of an appropriate counterfactual, or the comparator against which the economic burden of disease can be established. It is common practice to compare the current status with the situation that would prevail in the absence of the disease. For example, what would happen if no cases of HIV/AIDS had occurred in a given year?

Some studies do this by assessing disease prevalence, where the implied counterfactual is that no (new or pre-existing) illness or death occurred in the present time period. Others are based on incidence where the counterfactual is that there is no new morbidity or mortality in the specified time period. Both approaches are legitimate—a prevalence based approach is more suitable for ascertaining the total current economic burden of a disease, whereas an incidence based approach is more useful for ascertaining the expected impact of a disease in the future and the benefits of its potential prevention—but this makes it difficult to compare results across studies. Cost of illness studies have generally used a prevalence based approach, estimating costs of disease related intervention for a given year (but not future years), and the value of present and future lost production associated with deaths in this year. This approach therefore ignores the possibility that deaths averted by the elimination of the disease in the current period might generate increased health care costs in the future (due to some other disease that is experienced by those now surviving); this seems to be a peculiar and also inconsistent approach to cost estimation and counterfactual analysis.

Estimation methods for economic impact studies in health

We now turn briefly to the methods for estimating the quantity of interest associated with the different questions. Quantification is more straightforward, at least in principle, at the microeconomic level of households and businesses. The guiding principles are, firstly, that the time dimension of the health shock (the illness) should be captured. Reductions in income now might result in a fall in savings and investment that flow into reductions in future income, for example. Secondly, an effort should be made to measure actual (rather than imputed) losses. For example, it is common practice to assume that the time an individual reports losing due to illness can simply be multiplied by the wage rate to obtain the lost income. However, such an approach is likely to overesti-

mate these income or production losses because it does not take into account the coping strategies used by households or businesses to mitigate adverse circumstances associated with disease or injury (such as a household member or work colleague covering for the sick individual). The inclusion of controls (without disease or injury) provides one way of better ascertaining net economic consequences,⁸⁹ including the possibility that unaffected households or businesses might actually gain from the loss of others (such as a previously unemployed person replacing a sick worker). So aside from the actual net losses, it is important to note that ill health can also lead to a redistribution of resources.

At the societal level, we question the use of the cost of illness methodology. By focusing on health sector spending and lost labour productivity only, cost of illness studies provide only a partial picture of the true macroeconomic impact of disease, and fail to consider the contribution of depleted capital accumulation, investment in human capital, and demographic change to diminished economic growth. Instead, we recommend the application of a more general and dynamic assessment of forgone consumption opportunities. Specifically, if the focus lies on the impact on the market economy or GDP, an economic growth model based on either estimation or calibration is appropriate. This is essentially a set of regressions showing the relationship of national income to the quantity—and sometimes quality—of labour, controlling for other determinants. These modelling techniques have been applied not only to ill health in general,¹⁰⁻¹² but also to specific disease entities such as HIV/AIDS, malaria, and CVD.¹³⁻¹⁴ In the particular situation where the impact on different components of GDP is required—such as the effect of pandemic influenza on the education sector—a model that incorporates adjustments over time and the inter-linkages across different sectors of the economy is needed.¹⁵⁻¹⁶ However, the data requirements and computational costs tend to be high.

To estimate the overall welfare costs, where not only market based consumption losses but also the direct impact of poorer health is included, a recent development is specification of a “full-income” model. A monetary value is given to life years lost as a result of disease or injury, based on the willingness-to-pay methodology, and this cost is added to the losses of market consumption or income.¹⁷⁻¹⁹ To economists, such an approach provides a fuller measure of total economic welfare losses resulting from disease or injury, but there are a number of empirical concerns around whether willingness-to-pay estimates are very precise or useful in practice. We therefore recommend that empirically based estimates of market losses be identified and reported separately from hypothetically based estimates of foregone welfare based on willingness-to-pay.

Conclusion

Our motivation behind the production of new guidance on the conduct of economic impact studies in health was a concern that the literature is growing rapidly, but many of the results are of limited value to decision makers. Most commonly, this is because few studies have recognised that the quantity of interest differs according to the question being asked. Estimates of each of the components outlined earlier have, by themselves, a clear economic interpretation. However, because they measure different concepts, the combined estimate loses economic meaning. We have therefore tried to

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clarify the set of legitimate questions that can be answered by these studies. The first step is to identify the quantity of interest associated with these questions and the counterfactual implied by the question. Only then can the estimation method be finalised.

One final issue must be reiterated. Economic burden studies can shed light on the magnitude and distribution of costs associated with diminished health status, to individuals, households, firms, or society as a whole. However, the results should not be used as the means of setting priorities for allocating resources. The magnitude of the problem helps our understanding of the problems we face, but in order to set priorities for allocating resources to the control of these problems, information is required on many other factors such as the relative costs and effects of possible intervention strategies, and their impact on particular vulnerable groups.²⁰

Contributors: All authors contributed to the intellectual development of the WHO guide on which this article is based. DC and AES drafted the article; TTTE and DBE provided comments and written inputs at submission and resubmission stages.

Competing interests: None declared.

Provenance and peer review: Not commissioned, externally peer reviewed.

- 1 Hu TW, Sandifer FH. Synthesis of cost-of-illness methodology: part I. Report to the National Center for Health Services Research. US Department of Health and Human Services, 1981.
- 2 Ruger JP, Jamison D, Bloom D, Canning D. Health and the economy. In: Merson M, Black R, Mills A, eds. International public health: diseases, programs, systems, and policies. 2nd ed. Jones and Bartlett Inc, 2006:601-47.
- 3 Jack W, Lewis M. Health improvements and economic growth. World Bank, 2008.

- 4 World Health Organization. WHO guide to identifying the economic consequences of disease and injury. World Health Organization, 2009.
- 5 Shiell A, Gerard K, Donaldson C. Cost of illness studies: an aid to decision-making? *Health Policy* 1987;8:317-23.
- 6 Drummond M. Cost-of-illness studies: a major headache? *Pharmacoeconomics* 1992;2:1-4.
- 7 Byford S, Torgerson D, Raftery J. Economic note: cost of illness studies. *BMJ* 2000;320:1335.
- 8 Gertler P, Gruber J. Insuring consumption against illness. *Am Econ Rev* 2002;92:51-70.
- 9 Wagstaff A. The economic consequences of health shocks: evidence from Vietnam. *J Health Econ* 2007;26:82-100.
- 10 Bhargava A, Jamison D, Lau L, Murray C. Modeling the effects of health on economic growth. *J Health Econ* 2001;20:423-40.
- 11 Bloom D, Canning D, Sevilla J. The effect of health on economic growth: a production function approach. *World Dev* 2004;32:1-13.
- 12 Acemoglu D, Johnson S. Disease and development: the effect of life expectancy on economic growth. 2007. <http://baselinescenario.files.wordpress.com/2009/08/disease-and-development.pdf>.
- 13 Cuddington JT. Modeling with macroeconomic effects of AIDS, with an application to Tanzania. *World Bank Econ Rev* 1993;7:173-89.
- 14 Abegunde D, Mathers C, Adam T, Ortegon M, Strong K. The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 2007;370:1929-38.
- 15 Kambou G, Devarajan S, Over M. The economic effects of the AIDS epidemic in Sub-Saharan Africa: a general equilibrium analysis. *Revue d'économie du développement* 1993;1:37-62.
- 16 Smith RD, Keogh-Brown MR, Barnett T, Tait J. The economy-wide impact of pandemic influenza on the UK: a computable general equilibrium modelling experiment. *BMJ* 2009;339:b4571.
- 17 Usher D. An imputation to the measure of economic growth for changes in life expectancy. In: Moss M, ed. The measurement of economic and social performance. Columbia University Press, 1973:193-226.
- 18 Becker G, Philipson T, Soares R. The quantity and quality of life and the evolution of world inequality. *Am Econ Rev* 2005;95:277-91.
- 19 Murphy K, Topel R. The value of health and longevity. *J Polit Econ* 2006;114:871-904.
- 20 Baltussen RMPM, Adam T, Tan-Torres Edejer T, Hutubessy RCW, Acharya A, Evans D, et al. Making choices in health: WHO guide to cost-effectiveness analysis. World Health Organization, 2003.

CORRECTIONS AND CLARIFICATIONS

UK hospitals ordered to cut risk of drugs going wrongly into spinal fluid

In shortening the full (online) News article by Jane Feinmann to fit onto the page of our print issue (*BMJ* 2009;339:b5076, print publication 5 Dec, p 1276), we inadvertently deleted an important paragraph. This deletion might have left readers of the print journal with a misleading impression about the safety alerts. We should have retained that paragraph, which clarified the role of the National Patient Safety Agency: "The deadlines [for compliance with safety alerts] were created by the NPSA External Reference Group on Safer Neuraxial Devices, which was set up under the chairmanship of Professor Toft after the publication of the critical select committee report, in collaboration with the National Patient Safety Agency."

Predicting risk of osteoporotic fracture in men and women in England and Wales: prospective derivation and validation of QFractureScores

In this research paper by Julia Hippisley-Cox and Carol Coupland (*BMJ* 2009;339:b4229, print publication 5 Dec, pp 1291-5) the table is incorrect (a table from a previous paper by these authors was incorporated by us in error). The correct table is table 8 (Validation statistics for QFractureScore for osteoporotic fracture and hip fracture in validation cohort), which can be seen in the full version of the article on bmj.com.

Diagnosis and management of dengue

In this clinical review by Maria Glória Teixeira and Mauricio L Barreto (*BMJ* 2009;339:b4338, print publication 21 Nov, pp 1189-93) we said that the dengue virus belonged to the Flaviridae family. It doesn't; it belongs to the Flaviviridae family.

Endgames: Statistical question

The answer to the Endgames statistical question on study design (p 1383) was wrong (*BMJ* 2009;339:b5263; print publication 12 Dec). The correct answer is "a" and "c" [not "d" as given on p 1354].

Obituary: Neil Watson

In this obituary of Neil Watson by David K C Cooper (*BMJ* 2009;339:b5010, print publication 28 Nov, p 1258), we wrongly said that Neil Watson qualified from Oxford/Guy's Hospital, London. In fact, he qualified from Guy's Hospital.

Medical Capacity Act 2005 should be invoked

We wrongly used the word "medical" in the title of this letter by Tim Branton and colleagues (*BMJ* 2009;339:b5340, print publication 12 Dec, p 1327-8). The title should read: "Mental Capacity Act 2005 should be invoked."