The Global Burden of Disease Study: a useful projection of future global health?
Jonathan Cohen

Summary
One major conclusion of the Global Burden of Disease Study (GBDS) is that the global burden of disease will not change significantly from 1990 to 2020, in developed regions, developing regions or as a whole. Using the disability-adjusted life year (DALY), the Study estimates the burden as a result of 107 diseases, accidents and their disabling sequelae, disaggregated with respect to cause, sex, age and geographical region. The basic data used to construct estimates are sparse, and the DALY as a tool has received many criticisms. It obscures the distribution of disease and its impact in terms of handicap, and includes several social and economic value judgements. This weakens its power as a guide for the rational allocation of health resources at any point in time. Does it have use in guiding future planning and preventive action? At a global level, exceeding ecological capacity primarily through relative overpopulation is likely to be the greatest threat to overall health, yet overpopulation is not considered as a risk factor in itself. This reflects the understanding of health as an issue of the individual rather than the community. Together with the productivity-orientated weighting of DALYs, the Study appears to be more concerned with cost-effectiveness of health interventions rather than their equity. This underlies the reservations of the World Health Organization regarding the Study’s use as a rational tool in health policy.

Keywords: cost–benefit analysis, disability-adjusted life year, DALY, health planning

Introduction
The Global Burden of Disease Study (GBDS) was initiated in 1992 at the request of the World Bank, for use in its 1993 World Development Report. It was given four objectives:

(1) to develop internally consistent estimates of mortality from 107 causes of death, disaggregated by age and sex, for the world, and for eight demographic regions;
(2) to develop internally consistent estimates for the incidence, prevalence, duration and case-fatality for 483 disabling sequelae resulting from the above causes, disaggregated by age, sex and region;
(3) to estimate the fraction of mortality and morbidity attributable to 10 major risk factors, disaggregated by age, sex and region;
(4) to develop projection scenarios of mortality and disability, disaggregated by cause, age, sex and region to the year 2020.

It was a collaboration of over 100 researchers across the world, with full involvement from the World Bank and the World Health Organization (WHO). The full study fills several volumes. However, some of the most central findings were published as a series of four papers in the Lancet in 1997 and as a summary article in Science.

The GBDS uses the disability-adjusted life year (DALY) as its index of disease burden. This is disaggregated with respect to cause, age, sex and geographical region, and reflects both premature mortality and life lived with disability. It then goes on to project what the burden will be in the year 2020, again disaggregated for cause, age, sex and region. By using a universal index for the impact on society of disease and injury, it attempts to provide data that can be used as a basis for the rational allocation of health resources on a global scale.

The most surprising finding of the GBDS is that the total burden of disease in the world will not change significantly between 1990 and 2020. Moreover, the burden will not change significantly in the developed countries taken as a unit (established market economies and former Soviet economies), nor in the developing world as a unit. Is this a valid projection? Are the major factors that can be expected to shape future disease burden adequately modelled in the Study? Can one confidently utilize such findings to plan health interventions?

Despite their involvement in the GBDS, the WHO has expressed several reservations about the use of DALYs, and made no use of them in their 1997 World Health Report.

This paper will summarize the technique used by the GBDS to project the future global burden of disease and present a selection of its major findings. It will then survey and examine the criticisms the Study’s approach has received. Having considered the validity of the projections, it will specifically address the projection that there will be no change in global disease burden from 1990 to 2020.
Summary of GBDS technique

Data sources and estimate compilation

The GBDS was the first ever attempt to quantify the burden imposed by disease at a global level. In fact, only in Ghana had there been a country-wide attempt to quantify the health impact of different diseases. For the GBDS, epidemiological source data were used where they existed. Vital-registration data existed for approximately 30–35 per cent of all deaths in the year 1990. The estimates for other countries were based on sample registration data or small-scale population-study data sources. Comparisons were made between countries expected to have similar cause of death structures, reflecting common mortality rates, i.e. at the same stage of epidemiological transition. To support these estimates, community level mortality surveillance studies were used. Preliminary estimates were checked for miscoding, and modified to reflect the epidemiology of the diseases and injuries.

A whole range of data sources provided by experts were used to estimate the duration and severity of the disabling sequelae of disease and injury. These were reviewed by other experts, and were subjected to computer modelling, which checked the consistency of prevalence–incidence estimates for the disabling results of the diseases and injuries.

Calculating the disability-adjusted life year

The technical basis for DALYs is set out in the Bulletin of the World Health Organization. The DALY was designed as a measure of disease burden, so that the cost-effectiveness of a health intervention could be quantified in a universal fashion. Disease burden was defined as the combination of premature mortality and morbidity as a result of a disease or an injury. These were calculated as the sum of years of life lost (YLL, i.e. remaining life expectancy for fatal cases) plus the years lived with disability (YLD, i.e. remaining life expectancy for non-fatal cases, adjusted for the degree of disability remaining). The sum of these two indices is the disability-adjusted life year (DALY). Future years were discounted at a rate of 3 per cent.

The YLL was obtained as the standardized life-expectancy at a given age, taken from model life tables. However, it was modified to reflect the value of a year of life at a certain age. The young and the old add a social burden on other adults, so an age-weight function is used to incorporate this preference. A year of life lived at the age of 10 or 50 is valued as 1 year. Outside these years, a year of life is worth less; between these years, it is worth more.

The GBDS used disability as its measure of non-fatal health outcome following a disease or injury. This follows the international classification of impairments, disabilities and handicaps. Although a person lives in the context of their actual handicap, the comparison of handicaps was felt likely to exacerbate inequality. For this reason, disability was chosen as the expression of the non-fatal part of disease burden. Disabilities were weighted according to their impact on activities of daily living, and on recreation, education, procreation and occupation. Defined in this operational sense, they were reviewed by a panel of experts. A distinction was made between the severity and duration of a disabling sequel. These disabilities over specified periods of time were compared with one another and with mortality by means of person trade-off, to provide a measure of disability in the form of YLD.

Risk factors

Many of the disorders for which the DALYs had been calculated had known risk factors. Estimates were made of the disease burden attributable to these risk factors, as the sum

<table>
<thead>
<tr>
<th>Table 1 Causes of DALYs worldwide in 1990 and 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1990</strong></td>
</tr>
<tr>
<td><strong>Cause</strong></td>
</tr>
<tr>
<td>Lower respiratory infection</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
</tr>
<tr>
<td>Perinatal conditions</td>
</tr>
<tr>
<td>Unipolar major depression</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
</tr>
<tr>
<td>Tuberculosis</td>
</tr>
<tr>
<td>Measles</td>
</tr>
<tr>
<td>Road traffic accidents</td>
</tr>
<tr>
<td>Congenital abnormalities</td>
</tr>
<tr>
<td>COPD</td>
</tr>
<tr>
<td>War injuries</td>
</tr>
<tr>
<td>HIV</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

COPD, chronic obstructive pulmonary disease.
of the DALYs from each disease to which it contributes. The risk factors used were: malnutrition, poor water supply, sanitation and personal and domestic hygiene, unsafe sex, tobacco use, alcohol consumption, occupation, hypertension, physical inactivity, use of illicit drugs and air pollution.

Calculation of future projections

The projections were modelled on the most important disease and injury trends since 1950, and incorporate the roles of GDP, education, technological change and smoking intensity trends as underlying causes of change in disease and injury rates. Specific alterations are made to account for specific diseases, such as HIV and tuberculosis. Using World Bank fertility and with their own mortality rate projections, baseline, pessimistic and optimistic projections of YLL, YLD and DALYs were constructed.

Selected findings of the GBDS

There are abundant findings in the GBDS. The data discussed here can be found in the series of summary articles in the *Lancet*. The tables and figures are constructed on the basis of such data.

The major causes of DALYs in 1990 and 2020 are shown in Table 1. Lower respiratory infections (112.9 million), diarrhoeal diseases (99.6 million) and perinatal conditions (92.4 million) are projected to be replaced by ischaemic heart disease (82.3 million), unipolar major depression (78.7 million) and road traffic accidents (71.2 million) by 1990 as the leading causes of disease burden in the world. If DALYs are used to measure disease burden instead of mortality alone, in 1990, ischaemic heart disease and cerebrovascular disease are overtaken as the leading diseases by lower respiratory infections, diarrhoeal diseases, perinatal conditions and unipolar major depression (Table 2).

The projected changes in the burden imposed by the leading causes of DALYs are shown in Figure 1. Great reductions are projected in lower respiratory infections (70.2 million), diarrhoeal diseases (62.5 million) and perinatal conditions (57.7 million). Conversely, the burden from road traffic accidents is projected to be responsible for the largest increase (36.9 million). This is followed by projected increases in the DALYs as a result of ischaemic heart disease (35.6 million) and chronic obstructive pulmonary disease (28.5 million).

The total disease burden in the world, and the burden divided between developing and developed countries for 1990 and projected to 2020 are shown in Figure 2. There is no significant change in the millions of DALYs over this period for

---

**Table 2 Causes of death worldwide**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Deaths (000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischaemic heart disease</td>
<td>6260</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>4381</td>
</tr>
<tr>
<td>Lower respiratory infection</td>
<td>4299</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>2946</td>
</tr>
<tr>
<td>Perinatal conditions</td>
<td>2443</td>
</tr>
<tr>
<td>COPD</td>
<td>2211</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1960</td>
</tr>
<tr>
<td>Measles</td>
<td>1058</td>
</tr>
<tr>
<td>Road traffic accidents</td>
<td>999</td>
</tr>
<tr>
<td>Total</td>
<td>50467</td>
</tr>
</tbody>
</table>

COPD, chronic obstructive pulmonary disease.

**Figure 1** Projected worldwide changes in burden of disease 1990–2020 by cause. RTA, road traffic accidents; IHD, ischaemic heart disease; COPD, chronic pulmonary disease; TB, tuberculosis; LRI, lower respiratory infections.
developing countries (from 1218 to 1228 million), developed
countries (from 161 to 160.5 million), or for the world as a
whole (from 1379 to 1388 million).

The burden attributable to 10 major risk factors worldwide
in 1990 is shown in Figure 3. Malnutrition overshadows the
others, being responsible for 219.6 million DALYs. This is
followed by poor water supply, sanitation and domestic
and personal hygiene, together responsible for 93.4 million
DALYs.

---

**How valid is the technique?**

**Data sources and estimate compilation**

The findings of the GBDS are based on estimates. The approach
taken to generate such estimates has been criticized by the
DALY Review Group of the WHO. There is a fear that such
regional aggregates may suppress variations in the regions.9
However, the authors have acknowledged this as a weakness
of any aggregate measure, no different from the loss of

---

**Figure 2** Projected changes in burden of disease 1990–2020. White bars, 1990; black bars, 2020.

**Figure 3** Burden attributable to 10 major risk factors in 1990.
heterogeneity in mortality statistics. For example, the heterogeneity imposed by models based upon states of epidemiological transition (where demographic similarities are used to imply similarities in disease structure) can obscure the differences between the health of the rich and the poor within a population, whom Phillips described as living in different ‘epidemiological worlds’. As an attempt to improve on the information that was extant before the Study was undertaken, it draws attention to the need to gather further information. However, the vast lack of data for some regions at the time of the Study is cause for concern. Cooper et al. believe that until actual data are available that support the models used to construct the Study’s findings, they should not be used.

Calculating the DALY

As an overall indicator of disease burden, the DALY is potentially more accurate as it includes disability as well as mortality. Much disease burden has been overlooked in the past by using mortality data alone. This is especially true in the area of mental health. The WHO’s review group, however, felt that in combining the two aspects, more is lost than is gained. Although the data were also published in the form of separate YLL (mortality factor) and YLD (disability factor), their use has often been simply as a combined DALY. When disability and mortality were combined to rank all health interventions by cost-effectiveness in the State of Oregon, USA, the results were unpalatable to the general public, who appeared to feel that in some cases the saving of an individual life (‘rule of rescue’) is worth more than the equivalent disability distributed across several individuals. Furthermore, the review group noted that the DALY allows for no recognition that a disability may be contributed to by several disease causes. This fact would be overlooked if the Study’s findings were used to decide health intervention allocation.

The DALY has received much criticism for its inclusion of social value judgements. The quantification of health status cannot avoid the inclusion of some social values. This is well recognized. However, the Study authors stressed that as long these values are explicit one can decide if they are pertinent when the findings of the Study are used in practice. The concern, however, is that this valid point may be ignored by those using the tool in cost-effectiveness studies.

The different patterns in seeking health care between societies in their various forms reflect different views of health and disease. Some may feel that if a person is unable to perform the activities of daily living, to be educated, to have recreation, procreation or occupation, it is a matter for the health services. Others feel that this is an expected part of life, perhaps for support from the family. The WHO DALY Review Group believe that these differences are not taken into account in a model that ignores people’s actual health expectations. It is vital that the social values used to formulate the DALY are explicit, known and taken into consideration by those using them.

The various weighting systems used in the construction of the DALY are further examples of this value judgement. They appear to reflect the idea that health maximization (i.e. disease burden reduction) is an economic investment. The age-weighting system used seems to value the age of a person in terms of how much has been invested in them so far against what future return they could generate. Although educational level would be too blatant a form of prejudice, one wonders whether such age-weighting is also a prejudice, serving those who gain from the economic productivity of the individuals. Similarly, the assessment of severity of disability by expert panels would seem to blur the cultural differences that exist. The discounting of future years of life also reflects an economic consideration; however, it would seem reasonable to discount the future to some degree as a reflection of an everyday consideration. The use of regression analysis to test the sensitivity of such weightings would seem to show that they may be of significance under certain circumstances, despite the claims of the Study’s authors to the contrary.

Although aggregate pictures can be drawn up using such single indices as the DALY, the equitable distribution of health resources does require further knowledge of the impact of a disease on a specific person: the context in which they live. This determines the amount of assistance or intervention a person will actually require. As such, there is valid concern over the use of the Study’s findings in the allocation of health resources.

Risk factors

By connecting the DALYs that stem from diseases and accidents to the risk factors which cause them, there is an opportunity to rationally prioritize risk factor interventions. However, there will be rational motivation for a risk factor modification intervention only when the contribution of the risk factor has been analysed in the Study.

That poverty causes ill-health is undoubted. In its 1997 World Health Report, the WHO acknowledged that increasingly, health is influenced by social and economic circumstances over which the individual has little control. Yet the GBDS did not consider poverty or overcrowding as risk factors in themselves. Although disease burden is attributed to their sequelae, malnutrition, poor water supply, sanitation and hygiene, the study cannot provide a rational DALY-reducing impetus to deal with poverty and overcrowding as the root causes of such risk factors.

Validity of future projections

The Study’s authors believe that four factors are responsible for the projected changes: ageing of the population; spread of HIV; rise in tobacco-related mortality and disability; decline in
deaths caused by infectious, parasitic, respiratory, maternal, perinatal and nutritional diseases.

By their very nature, some of these trends are difficult to predict. There is still debate over the exact place of compression and expansion of morbidity during the epidemiological transition. This is likely to depend upon the facilities available for the chronic conditions, perhaps involving the fourth stage of transition, with advanced health care provision. Nevertheless, the increased numbers living into older age will contribute more cases of chronic and degenerative diseases, especially in conjunction with increasing smoking rates globally. Although best estimates for HIV rates were used, the confidence intervals are broad, and HIV is a major factor behind the projected increase in tuberculosis rates.

The increased use of motor vehicles appears to be a part of development. The World Bank has even stressed their role in ensuring competition within a developing economy. That the largest projected increase in disease burden should be attributable to road traffic accidents is cause for concern. The increase in depression is also perhaps integrally tied in with development, through changes in social structures and support networks, and migrations. Together with increased rates of smoking, they represent one path of development.

The projected decline in deaths caused by infectious, parasitic, respiratory, maternal, perinatal and nutritional diseases assumes that those countries at start of transition will reach the same situations as those that have gone before, albeit with different intermediate patterns. The advances made in the developed countries may well have been made only as a result of the continuing status of others as undeveloped. King has claimed that the health status of the world is dependent upon its ecological status, and that the current ecological status of the world is unsustainable. Is it feasible that all countries in the world will eventually follow the transitions of the western forerunners? Whether such advances can be made in the least developed countries may depend upon being able to break out of the demographic trap of overpopulation and warfare in which they are now.

The authors of the Study do not refer such massive population growth as one of the major determinants of the total burden of disease. The factors they list will explain the changes in distribution of disease. However, the four factors above alone do not explain why the burden of disease should remain the same in 2020. It seems plausible to attribute the negligible change in total burden within developed countries to the four factors suggested. However, in developing countries, on the basis of these factors alone, one would expect reduction in the burden. The massive population increases anticipated over the next 30 years may be the missing factor required to explain why no there is no projected decrease in disease burden.

As no projections were made based on alternative population scenarios, the study itself does not provide an impetus to deal with population control as a health intervention. This perhaps reflects what has been called the Hardinian taboo of ignoring the issue of population control. Although it has been traditional to assume that reduction in child mortality, a feature of demographic transition, will lead to reduction in fertility, there is increasing evidence that this is not the case, and that more direct action on fertility control may be necessary for other health interventions to have a real impact on reducing disease burden.

Conclusions

The projections from the Global Burden of Disease Study are based on many estimated data, and make several assumptions regarding the measurement of disability. As a tool, the DALY requires modifications, especially with regard to its application in radically different psychosocial and cultural settings. The DALY approach reflects the desire to formulate a single index to express the burden of disease on lost economic potential in the form of lost years of potentially productive life, rather than the burden of disease upon the individual as a whole. For these reasons it would seem dangerous to use the findings of the study in any detailed way with regard to the rationing of health resources.

The overall findings of its projections into the future raise several alarms. That the total burden of disease will remain unchanged by 2020 is likely to reflect the rapidly increasing population in developing countries. Population control would seem to be the most effective means of reducing the burden of disease in the world, yet as a health intervention it is not modelled as a variable in the projections themselves.

The burden of disease is projected to remain constant whereas the population size and life expectancy increase. This implies that more healthy life years are to be lived in the future than today. As a source of potential economic productivity, this would benefit the world. However, human suffering would not have been reduced. This issue of the cost-effective versus the equitable application of health interventions appears to underlie the WHO’s reservations regarding the Study. The overall findings of the Study offer a warning to those who may wish to make practical use of its details.

References


*Accepted on 2 August 2000*