3. The Global Burden of Disease concept

3.1 Introduction

The GBD concept, first published in 1996, constituted the most comprehensive and consistent set of estimates of mortality and morbidity yet produced (Murray & Lopez, 1996), and WHO now regularly develops GBD estimates at regional and global level for a set of more than 135 causes of disease and injury (Mathers et al., 2002; WHO, 2002a). A GBD study aims to quantify the burden of premature mortality and disability for major diseases or disease groups, and uses a summary measure of population health, the DALY, to combine estimates of the years of life lost and years lived with disabilities. The data are also broken down by age, sex and region.

WHO also supports NBD studies to obtain country-specific estimates for input to national policy. The national studies are based on the GBD concept and the data can be used in EBD assessments to estimate the contributions that environmental risk factors make to the overall disease burden. Over 30 countries are now undertaking NBD studies. Guidelines, software tools, and data for NBD studies are available from WHO (Mathers et al., 2001).

3.2 Summary measures of population health

Summary measures of population health measure the health of a population by combining data on mortality and non-fatal health outcomes into a single number. Besides the DALY, several other such measures have been devised, including the Quality-Adjusted Life Year (QALY), the Disability-Adjusted Life Expectancy (DALE) and the Healthy Life Year (HeaLY) (Weinstein & Stason, 1977; Murray & Lopez, 1996; Hyder, Rotllant & Morrow, 1998; Murray, Salomon & Mathers, 2000). The benefits and challenges of these measures have been examined (Anand & Hanson, 1997; Williams, 1999; Murray & Lopez, 1999b, Murray, Salomon & Mathers, 2000; Murray et al., 2002). As the DALY has been the most widely-used measure, and can be applied across cultures, we will focus on it in this guide.

The DALY measures health gaps as opposed to health expectancies. It measures the difference between a current situation and an ideal situation where everyone lives up to the age of the standard life expectancy, and in perfect health. Based on life tables, the standard life expectancy at birth is set at 80 years for men and 82.5 for women.

The DALY combines in one measure the time lived with disability and the time lost due to premature mortality:

$$DALY = YLL + YLD$$

where:
YLL = years of life lost due to premature mortality.
YLD = years lived with disability.

The YLL metric essentially corresponds to the number of deaths multiplied by the standard life expectancy at the age at which death occurs, and it can be rated according to social preferences (see below). The basic formula for calculating the YLL for a given cause, age or sex, is:

YLL = N x L

where:
N = number of deaths.
L = standard life expectancy at age of death (in years).

The DALY is based on the premise that the best approach for measuring the burden of disease is to use units of time. Having chosen units of time as the unit of measure, the burden of disease can still be calculated using incidence or prevalence measures. Time lost due to premature mortality is a function of the death rate and the duration of life lost due to a death at each age. Because death rates are incidence rates, there is no obvious alternative for mortality than to use an incidence perspective. By contrast, for non-fatal health outcomes, both incidence and prevalence measures have been routinely used. Thus, it is possible to calculate the number of healthy years of life lost because of people living in disease states, in terms of prevalent cases of disease in the population in the year of interest, or in terms of the incident stream of healthy years of life lost into the future for incident cases of the disease in the year of interest.

As noted above, the DALY measures the gap between the actual health status of a population and some "ideal" or reference status, using time as the measure. In developing the DALY indicator, Murray & Lopez (1996) identified two key value choices:

- how long "should" people in good health expect to live?
- how should we compare years of life lost through death, with years lived with poor health or disability of various levels of severity?

The first of these choices relates to the standard life expectancy used to calculate the YLL, and the second to the development of disability weights described in the following section.

3.3 Quantifying time lived with disability

There are at least two ways of measuring the aggregate time lived with a disability. One method is to take point prevalence measures of disability, adjusting for seasonal variation if present, and express them as an annual prevalence. The alternative is to measure the incidence of disabilities and the average duration of each disability. The product of the incidence and the duration will then provide an estimate of the total time lived with disability. This is the approach used for the DALY.

To estimate YLD on a population basis, the number of disability cases is multiplied by the average duration of the disease and a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (dead). The basic formula (without applying social preferences) for one disabling event is:

YLD = I x DW x L

where:	
YLD	= years lived with disability.
I	= number of incident cases.
DW	= disability weight.
L	= average duration of disability (years)

To use time as a common currency for non-fatal health states and for YLL, time must be defined and measured for living in non-fatal health states. To place a value on the time lived in non-fatal health states, health state weights are used to formalize and quantify social preferences for different states of health. Depending on how these weights are derived, they are referred to as disability weights, QALY weights, health state valuations, health state preferences or health state utilities. Most such weights are measured as a number on a scale of 0-1, where 0 is assigned to a state comparable to death and 1 is assigned to a state of ideal health. This assignment for the QALY is inverted compared to that used for the DALY (where 0 = perfect health and 1 = death), because the QALY measures equivalent healthy years lived, whereas the DALY measures loss of health.

Although the disability weights used in DALY calculations quantify societal preferences for different health states, the weights do not represent the lived experience of any disability or health state, or imply any societal value for the person in a disability or health state. Rather, they quantify societal preferences for health states in relation to the societal ideal of good health. Thus, a weight for paraplegia of 0.57 does not mean that a person in this health state is "half dead", that they experience their life as halfway between life and death, or that society values them less as a person compared to "healthy" people. It means that, on average, society judges a year with blindness (weight 0.43) to be preferable to a year with paraplegia (weight 0.57), and a year with paraplegia to be preferable to a year with unremitting unipolar major depression (weight 0.76). It also means that, on average, society would prefer a person to have a year in good health followed by death, than a year with paraplegia followed by death. Society would also prefer a person to live three years with paraplegia followed by death (3 years x 0.57 = 1.7 lost "healthy" years), than have one year of good health followed by death (2 lost years of good health).

Following the GBD terminology, and consistent with the WHO International Classification of Functioning, Disability and Health (ICF), the term "disability" is used broadly in BoD analyses to refer to departures from good or ideal health in any of the important domains of health. These include mobility, self-care, participation in usual activities, pain and discomfort, anxiety and depression, and cognitive impairment. In some contexts, "health" is understood to mean "absence of illness", but in the context of summary measures of population health, health is given a broader meaning. As well as implying the absence of illness, it also means that there are no impairments or functional limitations due to previous illness or injury. Note that disability (i.e. a state other than ideal health) may be short-term or long-term. For example, a day with a common cold is a day with disability.

Ideally, any weighting to be used in BoD analyses or economic evaluations should measure preferences for clearly defined health states. The Global Burden of Disease Study 1990 asked small groups of participants (medical and public health experts) to make a judgement about the severity of the condition and the preference for time spent in each severity level. To a large extent, this was necessitated by the lack of population information on the severity distribution of most conditions at global and regional levels. Table 3.1 gives some examples of disability weights.

The Netherlands has carried out a project to measure weights for 53 diseases of public health importance, using a methodology consistent with the GBD study (Stouthard et al., 1997). This study used more-specific disease stages or severity levels, so that judgements about the distribution of disease stages or severity levels in the population were not required. In addition, the study defined each disease stage in terms of the associated average levels of disability, handicap, mental well-being, pain and cognitive impairment, using a modified version of the EuroQol health status instrument.

The GBD 2000 project has adopted a similar approach to health state valuation, using a standard health state description based on eight core domains of health (mobility, self care, pain and discomfort, cognition, interpersonal activities, vision, sleep and energy, affect). As part of the World Health Survey being conducted by WHO (WHO, 2003), revised disability weights will be developed during 2003 that are based on health state valuations from large representative population samples in over 70 countries.

Table 3.1 Examples of disability weights[a]

Disease or sequelae	Mean disability weight (untreated form)	Mean disability weight (treated form)
AIDS	0.50	0.50
Infertility	0.18	0.18
Diarrhoea disease, episodes	0.11	0.11
Measles episode	0.15	0.15
Tuberculosis	0.27	0.27
Malaria, episodes	0.20	0.20
Trachoma, blindness	0.60	0.49
Trachoma, low vision	0.24	0.24
Lower respiratory tract infection, episodes	0.28	0.28
Lower respiratory tract infection, chronic sequelae	0.01	0.01
Cancers, terminal stage	0.81	0.81
Diabetes mellitus cases (uncomplicated)	0.01	0.03
Unipolar major depression, episodes	0.60	0.30
Alcohol dependence syndrome	0.18	0.18
Parkinson disease cases	0.39	0.32
Alzheimer disease cases	0.64	0.64
Post-traumatic stress disorder	0.11	0.11
Angina pectoris	0.23	0.10
Congestive heart failure	0.32	0.17
Chronic obstructive lung disease, symptomatic cases	0.43	0.39
Asthma, cases	0.10	0.06
Deafness	0.22	0.17
Benign prostatic hypertrophy	0.04	0.04
Osteoarthritis, symptomatic hip or knee	0.16	0.11
Brain injury, long-term sequelae	0.41	0.35
Spinal cord injury	0.73	0.73
Sprains	0.06	0.06
Burns (>60%) – long term	0.25	0.25

[a] Adapted from Murray & Lopez (1996).

3.4 Other social values

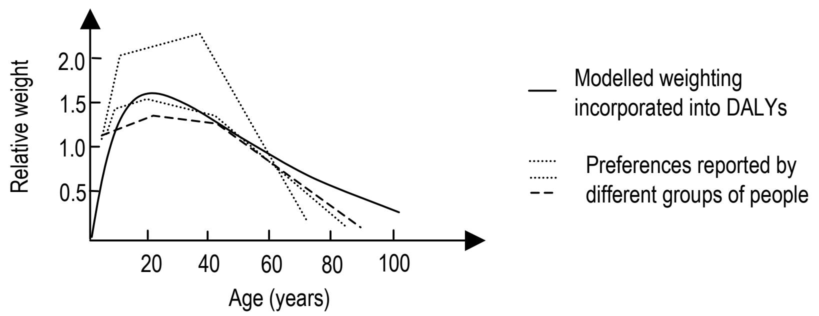
All summary measures of population health involve explicit or implicit social value choices. In particular, the DALY measures the gap between the actual health status of a population and some "ideal" or reference status. In developing the DALY indicator, Murray & Lopez (1996) identified five value choices: in addition to the two discussed above (standard years of life lost for a death, and disability weights), they took into account three additional social choices:

- Is a year of healthy life gained now worth more to society than a year of healthy life gained sometime in the future, for instance in 20 years?
- Are lost years of healthy life valued more at some ages than others?
- Are all people equal? For a given age, do all people lose the same amount of health through death, even if current life expectancies vary between population groups?

In the GBD study, a year of healthy life lived at younger and older ages was weighted lower than for other ages. In other words, the GBD study chose to value a year of life in young adulthood more than a year in old age or infancy. This choice was based on a number of studies that have indicated there is a broad social preference to value a year lived by a young adult more highly than a year lived by a young child, or lived at older ages (Institute of Medicine, 1986; Murray, 1996). Not all such studies agree that younger and older ages should be given less weight, nor do they agree about the relative magnitude of the differences.

A general pattern of the valuation of health according to age is represented in Figure 3.1.

Figure 3.1 Relative value of a year of life lived, by age: reported preferences and modelling[a]



[a]Adapted from Murray & Lopez (1996).

The function used to model the relative age weights is:

$$X_w = Cx^{-\beta x}$$

where:
X_w = weighted age (years)
C = constant
β = constant
x = age (years)

Age weights are the most controversial value choice built into the DALY. Some find age weights unacceptable on equity grounds (every year of life is of equal value *a priori*), others on empirical grounds (the standard age weights do not reflect actual social values). Murray & Acharya (1997) have argued that age weights are not in themselves inequitable, because everyone potentially lives through every age, and that they do reflect legitimate societal priorities.

Studies have shown that people have preferences regarding the moment at which death or disability occur (Murray, 1996; Murray & Acharya, 1997). People generally prefer a healthy year of life immediately, rather than in the future, if given the choice. The DALY measures the future stream of healthy years of life lost due to each incident case of disease or injury. It is thus an incidence-based measure, rather than a prevalence-based measure. To estimate the net present value of years of life lost, the GBD study applied a 3% time discount rate to years of life lost in the future. With this discount rate, a year of healthy life gained 10 years from now is worth 24% less than a year gained now.

For many years, a discount rate of 5% per annum has been standard in many economic analyses of health and in other social policy analyses, but recently environmentalists and renewable energy analysts have argued for lower discount rates for social decisions. The World Bank Disease Control Priorities study and the GBD project both used a 3% discount rate, and the US Panel on Cost-Effectiveness in Health and Medicine recently recommended that economic analyses of health also use a 3% real discount rate to adjust both costs and health outcomes (Gold et al., 1996). However, the panel also recommended that the sensitivity of the results to the discount rate should be examined.

Some recent NBD studies have chosen to include time discounting (see below), but not age weights, in the DALY calculations. Although WHO is continuing to report time-discounted and age-weighted DALYs as their standard, for the GBD 2000 study WHO is also making non-age-weighted DALYs available, with and without discounting. EBD studies may choose to weight or not to weight, depending on local preferences, but such studies should also compute standard age-weighted and discounted DALYs, so that the results can be compared with other, international studies.

3.5 Calculation of DALYs with discounting and age weighting

Discounting health with time reflects the social preference of a healthy year now, rather than in the future. To do this, the value of a year of life is generally decreased annually by a fixed percentage. For example, with a 3% discount rate, the YLL is:

$$YLL = \frac{N}{r}(1 - e^{-rL})$$

where:
N = number of deaths.
L = standard life expectancy at age of death (years).
r = discount rate (e.g. 3% corresponds to a discount rate of 0.03).

Similarly, the formula for YLD is:

$$YLD = \frac{I \times DW \times L\,(1 - e^{-rL})}{r}$$

where:	
I	= number of incident cases (-).
DW	= disability weight (-).
L	= duration of disability (years).
r	= discount rate.

If both age-weighting and discounting are applied, and the years between the event and the life expectancy are summed, the initially simple formulas for YLL and YLD become more complicated (formula for a single death). These formulas have also been programmed into calculation spreadsheet templates for DALYs that are available at the WHO website (see Annex 3.1).

$$YLL = \frac{KCe^{ra}}{(r+\beta)^2}\,[e^{-(r+\beta)(L+a)}\,[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}\,[-(r+\beta)a-1]] + \frac{1-K}{r}\,(1-e^{-rL})$$

where:	
a	= age of death (years).
r	= discount rate (usually 3%).
β	= age weighting constant (e.g. β=0.04).
K	= age-weighting modulation constant (e.g. K=1).
C	= adjustment constant for age-weights (e.g. C=0.1658).
L	= standard life expectancy at age of death (years).

Similarly, by replacing the standard life expectancy in the YLL formula by the duration of disease and by multiplying by the disability weight, the YLD formula becomes the following (for a single disabling event):

$$YLD = DW\,\{\frac{KCe^{ra}}{(r+\beta)^2}\,[e^{-(r+\beta)(L+a)}\,[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}\,[-(r+\beta)a-1]] + \frac{1-K}{r}\,(1-e^{-rL})\}$$

where:	
a	= age of death (years).
r	= discount rate (usually 3%).
C, β, K	= constants (see previous legend).
L	= duration of disability (years).
DW	= disability weight.

A calculation example for YLL is outlined in Box 3.1, using the spreadsheet template in Annex 3.1 to calculate DALYs. Similarly, an example calculation for YLD is provided in Box 3.2.

Box 3.1 Example of a Microsoft Excel worksheet for calculating YLL

DALY Parameters

0.03	Discount rate (r)	Standard discount rate is 0.03
0.04	Beta (b)	Standard age weights use beta=0.04
0.1658	Constant (C)	Standard age weights use C=0.1658
-0.07	-(b+r)	
0	K	K=0 (no age weights) to 1 (full age weights)

YLL for diarrhoea in Afro E[a]

	Population	Deaths	Deaths per 1000	Av. Age at death	Standard LE		YLLs	YLL per 1000
Males								
0-4	28 798 446	185 041	6.43	1.0	79.1	1.000	5 592 777	194.2
5-14	46 759 585	4 781	0.10	9.6	70.8	1.000	140 302	3.0
15-29	46 561 308	4 159	0.09	22.6	57.9	1.000	114 211	2.5
30-44	25 954 027	6 633	0.26	37.6	43.0	1.000	160 316	6.2
45-59	12 912 750	16 114	1.25	52.6	28.7	1.000	310 027	24.0
60-69	4 393 171	12 381	2.82	65.6	17.2	1.000	166 352	37.9
70-79	1 936 466	8 118	4.19	75.6	10.1	1.000	71 002	36.7
80+	417 445	1 518	3.64	85.6	5.3	1.000	7 389	17.7
Total	167 733 198	238 745	1.42	12.5	68.1		6 562 376	39.1
Females								
0-4	28 397 245	141 678	4.99	1.0	81.6	1.000	4 314 133	151.9
5-14	46 568 440	8 555	0.18	9.6	73.4	1.000	253 613	5.4
15-29	46 558 897	7 066	0.15	22.6	60.5	1.000	197 223	4.2
30-44	26 115 846	8 207	0.31	37.6	45.9	1.000	204 520	7.8
45-59	13 765 772	13 773	1.00	52.6	31.7	1.000	281 639	20.5
60-69	5 173 647	6 818	1.32	65.6	20.0	1.000	102 528	19.8
70-79	2 533 372	6 053	2.39	75.6	12.1	1.000	61 468	24.3
80+	700 406	2 116	3.02	86.6	5.8	1.000	11 321	16.2
Total	169 813 625	194 265	0	12.9	70.3		5,426 445	32.0

[a]Afro E includes 21 countries of sub-Saharan Africa that have the highest mortality pattern

Box 3.2 Example of a Microsoft Excell Worksheet for calculating YLD (single sequela)

DALY Parameters

0.03	Discount rate (r)	Standard discount rate is 0.03
0.04	Beta (b)	Standard age weights use beta = 0.04
0.1658	Constant (C)	Standard age weights use C = 0.1658
-0.07	-(b+r)	
1	K	K=0 (no age weights) to 1 (full age weights)

YLD for Alzheimer and other dementias

Australia	Population (x100 000)	Incidence	Incidence per 100 000	Age at onset	Duration	Disability weight	YLDs	YLD per 100 000
Males								
0-4	6.66	0	0	2.5	0.0	0.512	0.0	0.0
5-14	13.39	0	0	10	0.0	0.512	0.0	0.0
15-24	13.64	0	0	20	0.0	0.512	0.0	0.0
25-34	14.31	0	0	30	0.0	0.512	0.0	0.0
35-44	14.03	0	0	40	0.0	0.512	0.0	0.0
45-54	11.72	117	10	50	23.7	0.512	913.5	78.0
55-64	7.74	665	86	59.9	14.5	0.512	3 087.7	399.1
65-74	6.14	1 828	298	69.8	9.2	0.512	4 766.0	776.8
75+	3.46	6 918	2 001	80.7	3.8	0.512	6 404.1	1 852.2
	91.08	9 529	105	76.8	5.8	0.51	15 171	166.6
Females								
0-4	6.31	0	0	2.5	0.0	0.512	0.0	0.0
5-14	12.75	0	0	10	0.0	0.512	0.0	0.0
15-24	13.12	0	0	20	0.0	0.512	0.0	0.0
25-34	14.31	0	0	30	0.0	0.512	0.0	0.0
35-44	14.08	0	0	40	0.0	0.512	0.0	0.0
45-54	11.37	114	10	50	28.3	0.512	960.7	84.5
55-64	7.64	657	86	60	18.4	0.512	3 519.9	460.6
65-74	6.82	2 052	301	69.9	11.9	0.512	6 439.1	944.5
75+	5.62	11 482	2 043	81.3	4.3	0.512	11 557.7	2 056.5
	92.03	14 305	155	78.4	6.2	0.51	22 477.3	244.2

3.6 Relating summary measures of health to the causes of loss of health

BoD analysis quantifies loss of health in any of the important domains of health, including mobility, self-care, participation in usual activities, pain and discomfort, anxiety and depression, and cognitive impairment. Diseases and injuries are understood as proximal causes of loss of health, and risk factors and environmental determinants as distal causes of loss of health.

One fundamental goal in constructing summary measures is to identify the relative magnitude of different health problems according to causes (including diseases, injuries and risk factors). There are two widely used ways to attribute cause: categorical attribution and counterfactual analysis.

In categorical attribution, an event such as death is attributed to a single cause according to a defined set of rules. Thus, a death resulting from a combination of malnutrition and measles is categorically attributed either to malnutrition or to measles, according to the rules of the International Classification of Diseases. Such rules inevitably involve grey areas and degrees of arbitrariness in dealing with multicausality and comorbidity.

In counterfactual analysis, the contribution of a disease, injury or risk factor is estimated by comparing the current and future levels of a summary measure with the levels that would be expected under some alternative hypothetical scenario. For example, we could ask what the BoD would be if no one in the population had ever smoked. By comparing this estimate with the actual current burden, we can estimate the attributable burden of tobacco smoking.

Health gap measures use categorical attribution to attribute the fatal and non-fatal burden of diseases and injuries to an exhaustive and mutually exclusive set of disease and injury categories. In contrast, counterfactual analysis is generally used in health gap measures to attribute the BoD to health determinants and risk factors. For EBD studies, the use of counterfactual analysis to estimate the disease burden associated with risk factors is described in Section 4 and in the guides for specific risk factors.

3.7 The GBD 2000 study – an analysis of global mortality patterns

New life tables and detailed distributions of the causes of death have been developed for all 191 WHO Member States for the years 2000. The data are based on a systematic review of all available evidence from surveys, censuses, sample registration systems, population laboratories, and national vital registration systems on the levels and trends of child and adult mortality (Mathers et al., 2002). Complete or incomplete vital registration data, together with sample registration systems, cover 72% of global mortality. Survey data and indirect demographic techniques provide information on the levels of child and adult mortality for the remaining 28% of estimated global mortality. Separate estimates have been made of the numbers and distributions of deaths due to HIV/AIDS in countries with a substantial HIV epidemic.

3.8 The GBD 2000 study – epidemiological analyses for calculating YLD

The key to estimating YLD is to develop comprehensive and consistent estimates for the incidences and point prevalences of diseases. WHO programme participation in the development and finalization of the estimates ensures that final estimates reflect all information and knowledge available to WHO. A wide range of data sources are used for the analysis of incidence, prevalence and YLD, including disease registers, population surveys, epidemiological studies and health facility data (Mathers et al., 2002).

Work is underway to document and publish the epidemiological reviews underlying the GBD 2000 estimates. Draft documentation is available on the WHO website at www.who.int/evidence/nbd together with regional summary tables of the GBD 2000.

3.9 Main findings from the GBD 2000 study

Version 2 estimates of the GBD 2000 study are listed in the World Health Report 2002. This report also presents an analysis of the attributable burden for 20 major risk factors. Methods and results for the GBD 2000 study are described in more detail in Mathers et al. (2002). The main findings of the GBD studies can be summarized as a ranking of diseases

(Table 3.2) and risk factors (Table 3.3), according to their global importance in deaths and DALYs.

Table 3.2 Disease rankings according to the GBD 2000 study (version 2)[a]

Disease	Deaths (thousands	As % of total deaths	DALYs (thousands)	As % of total DALYs
Ischaemic heart disease	7 033	12.6%	57 626	4.0%
Lower respiratory infections	6 164	11.1%	91 160	6.3%
Cerebrovascular disease	5 344	9.6%	45 088	3.1%
Chronic obstructive pulmonary disease	2 621	4.7%	29 371	2.0%
HIV/AIDS	2 570	4.6%	79 992	5.5%
Perinatal conditions	2 505	4.5%	98 424	6.8%
Diarrhoeal diseases	2 020	3.6%	63 346	4.4%
Tuberculosis	1 569	2.9%	35 302	2.4%
Road traffic accidents	1 203	2.2%	38 061	2.6%
Trachea, bronchus, lung cancers	1 201	2.1%	11 195	0.8%

[a] Sources: Mathers et al. (2002); WHO (2002b).

Table 3.3 Selected risk factor rankings [a]

Risk factor	DALYs (thousands)	As % total DALYs	Deaths (thousands)	As % total deaths
Underweight	137 801	9.4%	3 748	6.6%
Unsafe sex	91 869	6.3%	2 886	5.1%
Blood pressure	64 270	4.4%	7 141	12.6%
Tobacco	59 081	4.0%	4 907	8.7%
Alcohol	58 323	4.0%	1 804	3.2%
Unsafe water, sanitation and hygiene	54 158	3.7%	1 730	3.1%
Cholesterol	40 437	2.8%	4 415	7.8%
Indoor smoke from solid fuels	38 539	2.6%	1 619	2.9%
Iron deficiency	35 057	2.4%	841	1.5%
Overweight	33 415	2.3%	2 591	4.6%
Zinc deficiency	28 034	1.9%	789	1.4%
Low fruit and vegetable intake	26 662	1.8%	2 726	4.8%
Vitamin A deficiency	26 638	1.8%	778	1.4%
Physical inactivity	19 092	1.3%	1 922	3.4%
Occupational risk factors for injury	13 125	0.9%	310	0.5%
Lead exposure	12 926	0.9%	234	0.4%
Illicit drugs	11 218	0.8%	204	0.4%
Unsafe health care injections	10 461	0.7%	501	0.9%
Lack of contraception	8 814	0.6%	149	0.3%
Childhood sexual abuse	8 235	0.6%	79	0.1%
Urban air pollution	7 865	0.5%	799	1.4%
Climate change	5 517	0.4%	154	0.3%
Occupational noise	4 151	0.3%	0	0.0%
Occupational airborne particulates	3 038	0.2%	243	0.4%
Occupational carcinogens	1 421	0.1%	146	0.3%
Occupational ergonomic stressors	818	0.1%	0	0.0%

[a] Source: WHO (2002a)

Main Issues

- The GBD study is the most comprehensive and consistent set of estimates of morbidity and mortality by age, sex and region.
- The DALY is a summary measure of population health, combining mortality and disability.
- The DALY measures a health gap, relative to an "ideal" life expectancy of 80 years for men and 82.5 years for women.
- The DALY is the sum of years of life lost and years of life lived with disability.
- A disability weight is used to characterize each disease or sequelae.
- Social preferences for the point in time or age at which a death or disability occurs are incorporated into DALY calculations.

Annex 3.1: An example of a DALY calculation template

(available at www.who.int/evidence/nbd, under "other files")

	A	B	C	D	E	F	G	H	I	J	K
2	**DISEASE:**	***[Enter Disease/Sequela name]***						Updated:	*[Date]*		
3	**REGION:**	***[Enter Country or Region name]***						By:	*[Name]*		
4	**PERIOD:**	***[Enter reference year]***						Status:	*[Preliminary, draft, final]*		

THIS TEMPLATE ENABLES CALCULATION OF YLL (See Part A below in rows 26 to 104)
YLD (See Part B below in rows 107 to 135)
DALYs (See Part C below in rows138 to 152)

IF YOU HAVE MORE THAN ONE SEQUELA FOR A DISEASE, CREATE A COPY OF THIS TEMPLATE FOR EACH SEQUELA AND ADD THE DALYs FOR ALL SEQUELAE.

1. Enter disease name, region and period in the yellow cells above.
2. Enter update information in the purple cells above right.
3. If required, change discount and age weight parameters for DALY calculation in the grey box below.
4. If required, change age groups (insert additional rows if needed, and adjust lookup formulae for standard LE)

DALY Parameters

0.03	Discount rate (r)	Standard discount rate is 0.03
0.04	Beta (b)	Standard age weights use beta=0.04
0.1658	Constant (C)	Standard age weights use C=0.1658
-0.07	-(b+r)	
0	K	K=0 (no age weights) to 1 (full age weights)

A. YLL template

A1.Enter population data in yellow cells (Column B) below.
A2. Enter numbers of deaths for 5 year age groups in green cells (Column C) below. (or death rates in next column and calculate numbers of deaths)
A3. If necessary, modify average ages at death (blue column (E)). This may be important for lowest and highest age groups.

	A	Population	Deaths	Deaths per 1,000	Av. Age at death	Standard LE	G	YLLs	YLL per 1,000
34	***Males***								
35	**0**	1,500,000	2,000	1.33	0.1	79.9	1.000	60,607	40.4
36	**1-4**	6,000,000	0	0.00	2.6	77.8	1.000	-	0.0
37	**5-9**	7,250,000	0	0.00	7.3	73.1	1.000	-	0.0
38	**10-14**	7,500,000	0	0.00	12.9	67.5	1.000	-	0.0
39	**15-19**	7,500,000	1,000	0.13	18.1	62.4	1.000	28,203	3.8
40	**20-24**	7,500,000	1,000	0.13	22.5	57.9	1.000	27,468	3.7
41	**25-29**	7,500,000	1,000	0.13	27.5	53.0	1.000	26,536	3.5
42	**30-34**	7,500,000	1,000	0.13	32.6	48.0	1.000	25,428	3.4
43	**35-39**	7,250,000	1,000	0.14	37.5	43.1	1.000	24,181	3.3
44	**40-44**	7,000,000	2,000	0.29	42.6	38.1	1.000	45,407	6.5
45	**45-49**	6,500,000	3,000	0.46	47.7	33.2	1.000	63,071	9.7
46	**50-54**	6,000,000	4,000	0.67	52.6	28.5	1.000	76,672	12.8
47	**55-59**	5,500,000	5,000	0.91	57.6	23.9	1.000	85,394	15.5
48	**60-64**	5,000,000	6,000	1.20	62.7	19.5	1.000	88,605	17.7
49	**65-69**	4,000,000	7,000	1.75	67.7	15.4	1.000	86,314	21.6
50	**70-74**	3,000,000	8,000	2.67	72.6	11.8	1.000	79,672	26.6
51	**75-79**	2,000,000	8,000	4.00	77.5	8.8	1.000	62,081	31.0
52	**80-84**	1,000,000	7,000	7.00	82.4	6.4	1.000	40,608	40.6
53	**85+**	500,000	6,000	12.00	89.0	3.9	1.000	21,991	44.0
54	**Total**	100,000,000	63,000	0.63	63.9	20.5		842,238	8.4
56	***Females***								
57	**0**	1,500,000	2,000	1.33	0.1	82.4	1.000	61,045	40.7
58	**1-4**	6,000,000	0	0.00	2.6	80.3	1.000	-	0.0
59	**5-9**	7,250,000	0	0.00	7.4	75.6	1.000	-	0.0
60	**10-14**	7,500,000	0	0.00	12.6	70.4	1.000	-	0.0
61	**15-19**	7,500,000	1,000	0.13	17.9	65.2	1.000	28,613	3.8
62	**20-24**	7,500,000	1,000	0.13	22.6	60.5	1.000	27,910	3.7
63	**25-29**	7,500,000	1,000	0.13	27.5	55.7	1.000	27,072	3.6
64	**30-34**	7,500,000	1,000	0.13	32.6	50.7	1.000	26,048	3.5
65	**35-39**	7,250,000	1,000	0.14	37.5	45.9	1.000	24,926	3.4
66	**40-44**	7,000,000	2,000	0.29	42.7	41.0	1.000	47,169	6.7
67	**45-49**	6,500,000	3,000	0.46	47.7	36.2	1.000	66,219	10.2
68	**50-54**	6,000,000	4,000	0.67	52.6	31.6	1.000	81,688	13.6
69	**55-59**	5,500,000	5,000	0.91	57.7	26.9	1.000	92,301	16.8
70	**60-64**	5,000,000	6,000	1.20	62.6	22.5	1.000	98,259	19.7
71	**65-69**	4,000,000	7,000	1.75	67.6	18.2	1.000	98,177	24.5
72	**70-74**	3,000,000	8,000	2.67	72.6	14.1	1.000	92,178	30.7
73	**75-79**	2,000,000	8,000	4.00	77.6	10.5	1.000	72,305	36.2
74	**80-84**	1,000,000	7,000	7.00	82.6	7.5	1.000	47,198	47.2
75	**85+**	500,000	6,000	12.00	90.0	4.3	1.000	23,941	47.9
76	**Total**	100,000,000	63,000	0	64.0	22.7		915,051	9.2

Annex 3.1: An example of a DALY calculation template *(cont'd)*

A1. YLL in study age groups

	Population	Deaths	Deaths per 1,000	Av. Age at death	YLLs	YLL per 1,000
Males						
0-4	7,500,000	2,000	0.3	0.1	60,607	8.1
5-14	14,750,000	-	0.0		-	0.0
15-29	22,500,000	3,000	0.1	22.7	82,207	3.7
30-44	21,750,000	4,000	0.2	38.8	95,016	4.4
45-59	18,000,000	12,000	0.7	53.5	225,138	12.5
60-69	9,000,000	13,000	1.4	65.4	174,919	19.4
70-79	5,000,000	16,000	3.2	75.0	141,752	28.4
80+	1,500,000	13,000	8.7	85.5	62,599	41.7
Total	100,000,000	63,000	0.6	63.9	842,238	8.4
Females						
0-4	7,500,000	2,000	0.3	0.1	61,045	8.1
5-14	14,750,000	-	0.0		-	0.0
15-29	22,500,000	3,000	0.1	22.7	83,595	3.7
30-44	21,750,000	4,000	0.2	38.9	98,143	4.5
45-59	18,000,000	12,000	0.7	53.5	240,208	13.3
60-69	9,000,000	13,000	1.4	65.3	196,437	21.8
70-79	5,000,000	16,000	3.2	75.1	164,484	32.9
80+	1,500,000	13,000	8.7	86.0	71,140	47.4
Total	100,000,000	63,000	0.6	64.0	915,051	9.2

B. YLD template

B1. Enter population data in yellow cells (Column B) below (if have not entered them above for YLL).
B2. Enter incidence rates, age at onset and duration in green cells (Columns D, E and F)
B3. Enter disability weights in blue cells (Column G) below.

	Population	Incidence	Incidence per 1,000	Age at onset	Duration (years)	Disability Weight	YLDs	YLD per 1,000
Males								
0-4	7,500,000	0	0	2.5	0.0	0.500	-	0.0
5-14	14,750,000	0	0	10.0	0.0	0.500	-	0.0
15-29	22,500,000	0	0	22.5	0.0	0.500	-	0.0
30-44	21,750,000	0	0	37.5	0.0	0.500	-	0.0
45-59	18,000,000	0	0	52.5	0.0	0.500	-	0.0
60-69	9,000,000	18,000	2	65.0	10.0	0.500	77,755	8.6
70-79	5,000,000	50,000	10	75.0	5.0	0.500	116,077	23.2
80+	1,500,000	45,000	30	85.0	3.0	0.500	64,552	43.0
Total	100,000,000	113,000	1.1	77.4	5.0	0.50	258,383	2.6
Females								
0-4	7,500,000	0	0	2.5	0.0	0.500	-	0.0
5-14	14,750,000	0	0	10.0	0.0	0.500	-	0.0
15-29	22,500,000	0	0	22.5	0.0	0.500	-	0.0
30-44	21,750,000	0	0	37.5	0.0	0.500	-	0.0
45-59	18,000,000	0	0	52.5	0.0	0.500	-	0.0
60-69	9,000,000	27,000	3	65.0	10.0	0.500	116,632	13.0
70-79	5,000,000	75,000	15	75.0	5.0	0.500	174,115	34.8
80+	1,500,000	60,000	40	85.0	3.0	0.500	86,069	57.4
Total	100,000,000	162,000	1.6	77.0	5.1	0.50	376,816	3.8

C. Total DALYS = YLL+YLD

	Males			*Females*			*Persons*		
	Population	DALYs	DALYs per 1,000	Population	DALYs	DALYs per 1,000	Population	DALYs	DALYs per 1,000
Age									
0-4	7,500,000	60,607	8.1	7,500,000	61,045	8.1	15,000,000	121,652	8.1
5-14	14,750,000	-	-	14,750,000	-	-	29,500,000	-	-
15-29	22,500,000	82,207	3.7	22,500,000	83,595	3.7	45,000,000	165,801	3.7
30-44	21,750,000	95,016	4.4	21,750,000	98,143	4.5	43,500,000	193,159	4.4
45-59	18,000,000	225,138	12.5	18,000,000	240,208	13.3	36,000,000	465,346	12.9
60-69	9,000,000	252,674	28.1	9,000,000	313,068	34.8	18,000,000	565,742	31.4
70-79	5,000,000	257,829	51.6	5,000,000	338,599	67.7	10,000,000	596,428	59.6
80+	1,500,000	127,151	84.8	1,500,000	157,208	104.8	3,000,000	284,359	94.8
Total	100,000,000	1,100,621	11.0	100,000,000	1,291,867	12.9	200,000,000	2,392,487	12.0