A National Burden of Disease Calculation: Dutch Disability-Adjusted Life-Years

ABSTRACT

Objectives. This study estimated the burden of disease due to 48 major causes in the Netherlands in 1994 in disability-adjusted life-years (DALYs), using national epidemiologic data and disability weights, and explored associated problems and uncertainties.

Methods. We combined data from Dutch vital statistics, registrations, and surveys with Dutch disability weights to calculate disease-specific health loss in DALYs, which are the sum of years of life lost (YLLs) and years lived with disability (YLDs) weighted for severity.

Results. YLLs were primarily lost by cardiovascular diseases and cancers, while YLDs were mostly lost by mental disorders and a range of chronic somatic disorders (such as chronic nonspecific lung disease and diabetes). These 4 diagnostic groups caused approximately equal numbers of DALYs. Sensitivity analysis calls for improving the accuracy of the epidemiologic data in connection with disability weights, especially for mild and frequent diseases.

Conclusions. The DALY approach appeared to be feasible at a national Western European level and produced interpretable results, comparable to results from the Global Burden of Disease Study for the Established Market Economies. Suggestions for improving the methodology and its applicability are presented. (*Am J Public Health.* 2000;90:1241–1247)

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For evidence-based public health policy-making, empirical information on the health status of the population is an essential element. Traditionally, mortality and its derivative, life expectancy, have been important indicators of health. With the impressive increase in life expectancy at birth over the past decades,[1] public health attention has moved toward the quality of the life-years gained—that is, to morbidity and health-related quality of life, in addition to mortality.[2–4] This has led to the development of "composite health measures," in which health losses through mortality and morbidity are combined. One of these is the disability-adjusted life-year (DALY).

The DALY concept was developed by Murray and Lopez in their authoritative Global Burden of Disease (GBD-1990) project.[5–9] Essentially, the DALY is aggregated from disease-specific mortality and morbidity data, including an appraisal of the severity of the functional consequences of the disease. Hence, the measure enables comparisons between health losses due to mortality and morbidity and health losses attributable to different diseases. Burden of disease calculations in DALYs may therefore help in setting priorities among diseases and disorders for policy-making, interventions, and research.

The first results of the DALY approach as published in the GBD-1990 study are interesting and promising, but its usefulness for practical health policy-making remains largely to be proved. Theoretically, public health policies can be evaluated by calculating health improvements in terms of DALYs, and DALYs may also be applied in estimating the possible health profits gained by intervention alternatives.[10–12] Another possible use of DALYs is in assessing the importance of risk factors, such as smoking and environmental factors, by calculating associated DALYs.[13] It is evident that in addition to assessments of health gains or losses, considerations regarding the distribution of health and the cost-effectiveness of interventions affect prioritization and policy decisions.[14]

This report describes an estimation of the burden of disease due to 48 major causes for the Netherlands in 1994, using Dutch disability weights combined with epidemiologic data from medical registrations and surveys. The study was carried out within the framework of the Dutch Public Health Status and Forecast 1997, a 4-year comprehensive public health report.[15] The main goal of the study was to explore the problems and uncertainties that were encountered when the DALY approach was applied at the level of a single country.

Methods

The Dutch Public Health Status and Forecast 1997 report assessed the current and future state of public health in the Netherlands.[15] It included 52 diseases accounting for 45% to 50% of general practitioner diagnoses in 1994, 70% of deaths, and 65% of disease-attributable costs.[15] Criteria for the selection of the diseases were as follows: high total or premature mortality (>2% of total deaths, >2% of deaths at younger than 25 years, or >2% of total life-years lost), strong increase in mortality (>2% yearly increase), high morbidity (>2% of incident or prevalent cases in primary care, >1% of hospital discharge diagnoses,

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>2% of cases of absence from work due to sickness, or >2% of nursing home care), avoidable through primary or secondary prevention or health care, and high health care costs (>1% of total costs). "Diseases" were understood here as groups of associated conditions based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*), such as anxiety disorders and mental retardation. Some impairments, such as hearing and visual impairments, were also included as diseases. For 5 diseases—psychiatric disorders in children, (para)dental disorders, Down syndrome, premature births, and health problems among full-term newborns—no DALYs were calculated, because no reliable epidemiologic information was available. Osteoporosis was left out because it was considered a risk factor, not a disease. For the DALY calculations, the group of external causes of injury and poisoning was divided into 3 groups of "diseases": road traffic accidents, home and leisure accidents, and suicide. In total, data for the calculation of DALYs were available for 48 diseases (see Table 1).

Calculation of a burden of disease in DALYs involves data on mortality ("quantity of life lost") and on morbidity ("quality of life lost"). The burden of disease due to mortality consists of the total number of years of life lost (YLLs). This was calculated for each disease as the age-specific mortality multiplied by age-specific life expectancy based on standard life-table analysis, with Dutch life tables for 1994 used as the reference (standardized for the 1994 population of the Netherlands).

The burden of a disease due to morbidity was expressed by Murray and Lopez in the GBD-1990 project as years lived with disability (YLDs), calculated as the incidence multiplied by the average time spent with a disease, weighted for the extent of associated disability caused by the disease.[5] In our study, YLDs were estimated by multiplying the 1994 point prevalence for each disease (in some cases estimated from incidence and duration) by the corresponding disability weight. A best guess of the prevalence for each disease was based on a combination of up to 5 different general practitioner registrations or other medical care registrations[15] (in most cases, the mean of the prevalences reported in the different registrations). For some diseases, we considered prevalence data from population surveys to be more appropriate because of expected substantial underrecording in medical records (depression, anxiety disorders, alcohol dependence, mental retardation), or because the definitions of the disease stages for which disability weights had been obtained were based on actual survey questions (visual and hearing impairments).

To arrive at YLDs, we multiplied the disease prevalence by its disability weight. These weights were established in the Dutch Disability Weights Study, following a modified version of the GBD-1990 valuation protocol; for a detailed account of the procedures used, see Stouthard et al.[16] In short, in that study, most diseases were subdivided into disease stages considered homogeneous with respect to functional status, treatment, and prognosis. The 175 disease stages were valuated by 3 panels of medical experts. First, 16 disease stages were valuated in day-long panel sessions by person trade-off methods. These so-called indicator conditions were selected because their expected valuations should evenly cover the total range, from the best to the worst imaginable health. Furthermore, they should have a sizable public health impact and they should be relatively easy to recognize and interpret. The mean disability weights for these indicator conditions were then used to construct a disability scale on which the remaining 159 disease stages were interpolated. This task was conducted by the same medical experts in an individual postal procedure.

Generally, disease stages were valuated by assuming a duration of 1 year. However, some of the selected diseases (e.g., influenza) have only a brief duration and are followed in most cases by full recovery. Those diseases were valuated as an "annual profile" (e.g., "a healthy year including a 2-week episode of influenza"), and the disability weight was multiplied by the (yearly) incidence of the disease—not by the point prevalence—to arrive at YLDs.

To calculate YLDs on the basis of the prevalence data for the disease as a whole and the disability weights for its separate stages, it was necessary to combine the disability weights of the disease stages into 1 disease disability weight. Therefore, the average disability weight of a disease was calculated, to which the stage disability weights contributed according to their share in the disease prevalence. The required distribution of the prevalence over the disease stages was obtained through consulting experts for each disorder and, in some cases, by additional modeling.

Two components of the original DALY measure as developed by Murray and Lopez in the GBD-1990 study—weighting for age and discounting of YLLs and YLDs—were not applied in this study. Age weighting and discounting are controversial issues.[5,17] In our study design, it was considered inappropriate to discount future health losses, because the context of our burden of disease estimation is entirely contemporary or cross-sectional. Although the YLLs and YLDs may suggest a cohort interpretation of our burden of disease estimation in DALYs, the interpretation is cross-sectional in the sense that it is an estimation of the health loss in the Netherlands in 1994. This means that there is no future health loss in this estimation. A practical reason for not discounting or applying age weights is the need to guarantee maximal transparency of the figures. We therefore advocate applying weighting schedules such as age weights or discounting, if considered appropriate, separately and afterward.

An impression of the validity of the calculated burden of disease in DALYs was obtained in 2 ways. First, we compared our results with the GBD-1990 results for the Established Market Economies (EME), which include the Netherlands. For this comparison, the DALYs from the GBD-1990 study without age weighting and discounting were taken. Second, a limited sensitivity analysis was performed for 4 diseases to evaluate the effects of uncertainty in the prevalence or incidence data on the one hand and in the disability weights on the other hand. Two highly prevalent but relatively mild diseases, acute sinusitis (a disease with a short duration) and atopic eczema (chronic), were compared with 2 diseases that are less prevalent and more severe (heart failure and rheumatoid arthritis). The distribution of the prevalence (or incidence) of these diseases was available from various medical care registrations.

From the different figures from these registrations, we calculated the standard error by assuming a normal distribution. For the distribution of the disability weights, we also calculated the standard error, which was based on the 95% confidence interval of the combined disability weights. This confidence interval was calculated for each disease as a weighted average of the 95% confidence intervals of the disability weights of the disease stages, as they are given by Stouthard et al.[16] We calculated the standard error of the YLDs by combining the standard error of the prevalence and the disability weight. Therefore, the square root of the sum of both relative standard errors (squared) was calculated.

Results

The results of the burden of disease calculations are presented in Table 1, arranged by number of DALYs (in descending order). The second and third columns show the absolute numbers of deaths in 1994 and the calculated numbers of YLLs. The fourth column contains the prevalence (or incidence) data, which, after multiplication by the (combined) disability weight for each disease given in the fifth column, result in the number of YLDs in the sixth column. The table ends by showing the calculated burden of disease in DALYs in the last

TABLE 1—Burden of Disease Calculations for the Netherlands, 1994

Disease/Disorder (By Order of DALYs)	Mortality		Morbidity			Burden of Disease
	Deaths	YLLs	Prevalence *(Incidence)*	Disability Weight	YLDs	DALYs
Ischemic heart disease	20 699	221 000	154 400	0.29	44 500	265 400
Anxiety disorders	...[a]	...[a]	1 273 400	0.17	218 900	218 900
Cerebrovascular disease	12 595	110 400	97 300	0.61	59 200	169 600
Visual impairments[b]	...[a]	...[a]	1 750 900	0.10	165 900	165 900
Chronic nonspecific lung disease (chronic bronchitis, emphysema, asthma)	5 697	50 100	462 700	0.23	104 800	155 000
Alcohol dependence[b]	569	...[c]	279 800	0.55	153 900	(153 900)
Lung cancer	8 566	115 300	18 500	0.43	8 000	123 300
Depression[b]	...[a]	...[a]	488 600	0.23	112 800	112 800
Hearing impairments (from noise, old age)[b]	...[a]	...[a]	1 489 100	0.07	104 000	104 000
Diabetes mellitus	3 149	34 500	268 400	0.20	53 000	87 500
Breast cancer	3 555	64 400	72 500	0.27	19 300	83 700
Osteoarthritis (of the limbs)	...[a]	...[a]	403 100	0.19	75 300	75 300
Road traffic accidents[d]	1 322	47 500	58 800	0.44	25 300	72 800
Heart failure	6 726	52 100	93 600	0.15	14 400	66 500
Dementia	3 605	21 200	58 000	0.71	41 100	62 300
Colon and rectum cancer	4 109	50 100	46 400	0.22	10 400	60 500
Lower respiratory infections-P[e]	4 711	32 000	*686 700*	0.04	25 400	57 400
Suicide	1 584	50 300	...	...	...	50 300
Mental retardation[b]	...[a]	...[a]	102 100	0.45	46 400	46 400
Rheumatoid arthritis	268	2 700	80 700	0.53	42 300	45 100
Home and leisure accidents[d]	2 070	28 500	86 600	0.17	14 900	43 400
Contact eczema[f]	...[a]	...[a]	*605 400*	0.07	42 400	42 400
Stomach cancer	1 979	23 900	8 300	0.33	2 700	26 600
Prostate cancer	2 374	18 300	18 200	0.34	6 100	24 400
Parkinson's disease	855	6 400	26 500	0.68	17 900	24 300
Congenital anomalies of the circulatory system	242	15 900	22 200	0.13	2 900	18 900
Non-Hodgkin's lymphoma	1 051	15 900	7 700	0.31	2 400	18 300
Schizophrenia	...[a]	...[a]	26 300	0.66	17 300	17 300
Atopic eczema	...[a]	...[a]	238 100	0.07	16 700	16 700
AIDS	444	15 700	1 400	0.57	820	16 500
Epilepsy	172	4 900	94 300	0.11	10 400	15 200
Congenital anomalies of the central nervous system	105	7 500	14 600	0.50	7 200	14 700
Esophagus cancer	974	13 800	700	0.76	530	14 300
Aneurysm of the abdominal aorta	1403	14 100	...[g]	...[g]	...[g]	14 100
Dorsopathies	45	460	226 200	0.06	13 600	14 000
Skin cancer	509	10 300	28 000	0.06	1 500	11 800
Multiple sclerosis	199	4 400	13 300	0.53	7 100	11 500
Influenza-P[e,h]	136	990	*1 044 400*	0.01	10 400	11 400
Acute infections of the urinary system-P[e]	160	1 100	*649 200*	0.01	9 500	10 600
Upper respiratory infections-P[e]	...[a]	...[a]	*3 246 000*	0 003	8 700	8 700
Septicemia	535	8 000	...[g]	...[g]	...[g]	8 000
Intestinal infectious diseases-P[e]	48	560	*380 000*	0.02	*6 300*	6 900
Inflammatory bowel disease	56	790	16 800	0.20	3 400	4 200
Ulcers of stomach and duodenum-P[e]	418	3 600	*17 200*	0.02	340	4 000
Meningitis[i]	86	2 600	4 000	0.31	1 300	3 900
STD (bacterial only)[i]	...[a]	...[a]	36 700	0.07	2 600	2 600
Tuberculosis[i]	140	1 400	1 000	0.23	240	1 700
Hip fracture[i]	...[j]	...[j]	8 800	0.19	1 700	(1 700)

Note. DALYs = disability-adjusted life-years; YLLs = years of life lost; YLDs = years lived with disabilities. We used standardized 1994 epidemiologic data from Ruwaard and Kramers[15] and (combined) disability weights based on data from Stouthard et al.[16] The population of the Netherlands in 1994 was about 15.4 million. Figures exceeding 1000 were rounded to the nearest 100, and figures less than 1000 to the nearest 10, except for mortality and disability weight. Figures in italics are incidences; parentheses indicate that a figure does not include YLLs.

[a]Mortality figure and number of years of life lost are very low and have almost no significance.

[b]Because of acknowledged underrecording prevalence in medical registrations, figures from surveys were used (posttraumatic stress disorder was not included in the survey).

[c]Figure is not known since the disease is registered under diverse *International Classification of Diseases* categories that cannot be disaggregated, or because no age-specific prevalence data were available.

[d]Numbers concern only lasting consequences after 1 year, except for mortality and YLL.

[e]"P" after a disease indicates that the disease (or [some of] its stages) were valuated as an annual profile (e.g., 2 weeks ill and 50 weeks healthy).

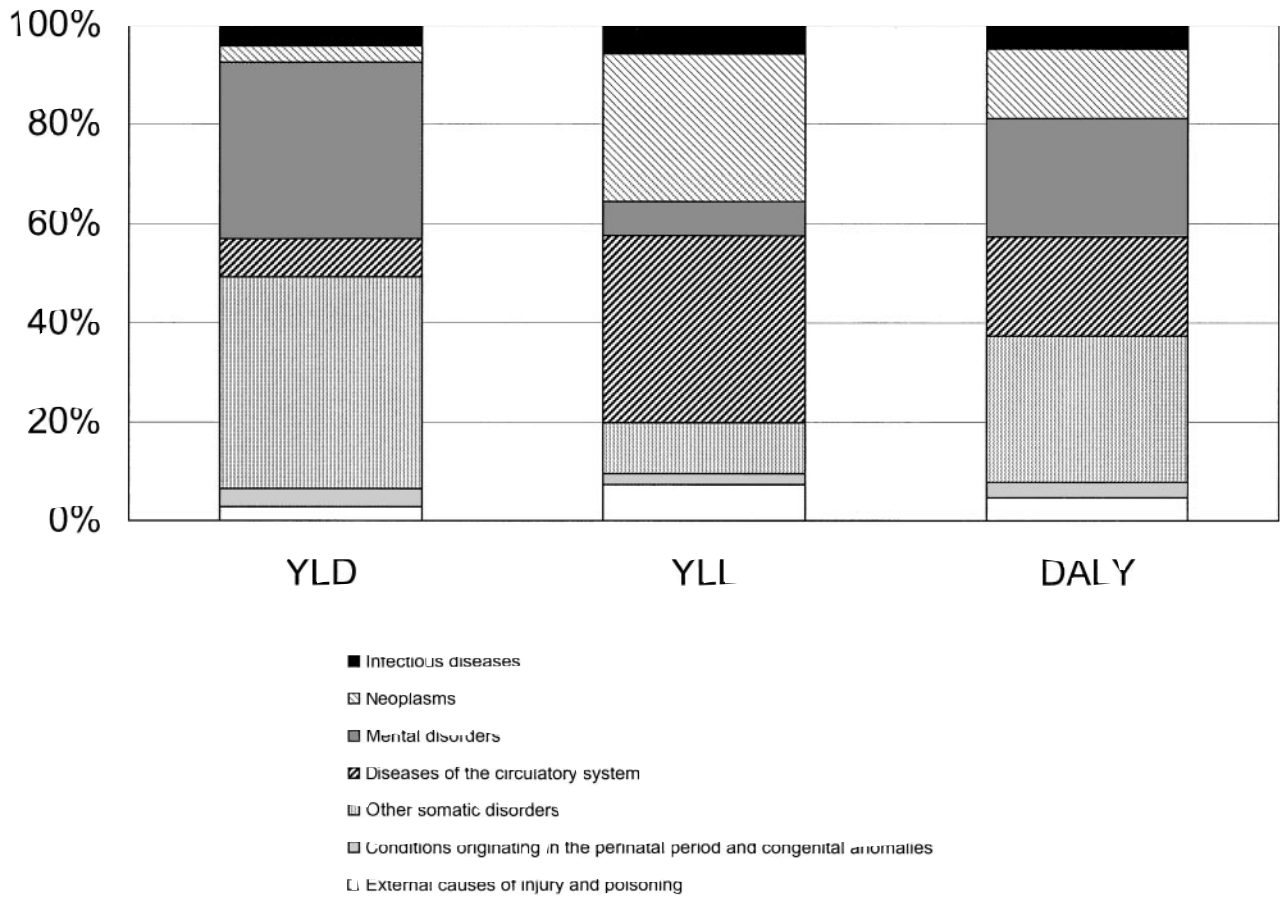
[f]No disability weight was derived for contact eczema. Weight of atopic eczema was used.

[g]Incidence or prevalence figure and YLD are very low and have almost no significance; therefore, no disability weight was derived.

[h]Incidence was corrected for the estimated fraction of influenza patients actually visiting a general practitioner (ca. 30%).

[i]Public Health Status and Forecasts 1997 provided only an incidence, while the stage description(s) required a prevalence, which was calculated estimating incidence and duration of the disease stage(s) (and in some cases mortality).

[j]Mortality figure and YLL are not presented, since cases are already registered under accidents (road, home and leisure).



Note. "Infectious diseases" are from several chapters of the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*). "Neoplasms," "diseases of the circulatory system," "conditions originating in the perinatal period and congenital anomalies" (also includes mental retardation), and "external causes of injury and poisoning" are defined as in the *ICD-9-CM* chapters. "Mental disorders" includes (attempted) suicide but excludes mental retardation. "Other somatic disorders" is a residual category.

FIGURE 1—Distribution of the numbers of years of life lost (YLLs), years lived with disabilities (YLDs), and disability-adjusted life-years (DALYs) lost in the Netherlands, caused by 48 diseases grouped into 7 large diagnostic categories.

column, which is the sum of the YLLs and YLDs for each disorder.

Comparing absolute mortality and YLLs shows that diseases causing a large number of deaths generally also rank high in YLLs. As expected, a relative upgrade for YLLs in the rank order occurs for diseases that cause death at relatively young ages (e.g., breast cancer). Within the YLD ranking, it is clear that some diseases rank high on the basis of their disability weight (e.g., cerebrovascular disease) and others on the basis of their high prevalence (e.g., hearing impairments). Similarly, in the DALY ranking, some diseases rank high because of their high contribution in YLLs (e.g., lung cancer), in YLDs (e.g., psychiatric disorders and rheumatoid arthritis), or in both (e.g., ischemic heart diseases, chronic nonspecific lung diseases, and diabetes).

Figure 1 summarizes the results. Here, the YLLs, YLDs, and DALYs for the diseases from Table 1 are added up within 7 large diagnostic categories and shown as percentages of the total. The figure demonstrates that the YLLs are dominated by diseases of the circulatory system and by neoplasms, while the YLDs are mainly affected by mental disorders and by "other" (largely chronic) physical diseases (such as chronic nonspecific lung disease, diabetes, osteoarthritis, and visual and hearing impairments). These 4 diagnostic groups caused approximately equal numbers of DALYs. The total number of calculated YLDs is approximately 1.5 times the number of YLLs.

Table 2 shows the top 10 diseases in DALYs for the Netherlands and for the EME (from the GBD-1990 study), with the burden of each disease as a percentage of the total number of DALYs for the area observed. Six of the 10 most important diseases in the Netherlands appear in the top 10 for the EME: ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease (including asthma), lung cancer, depression, and diabetes. Alcohol dependence, which is 6th in the Netherlands, ranks 13th in the EME. Three other disorders that are not included in the top 10 for the EME (anxiety disorders, visual and hearing impairments) represented, in the Dutch study, broader categories than the definitions used in the EME. Osteoarthritis, road traffic accidents, and dementia, which are in the EME top 10, also rank high in the Netherlands (12th, 13th, and 15th).

Table 3 shows the results of the brief sensitivity analysis. The prevalence (or incidence)

TABLE 2—Comparison of DALYs for the Netherlands With Results From the Global Burden of Disease (GBD-1998) Study for the Established Market Economies (Without Age Weights or Discount for Future Years)

Netherlands		Established Market Economies (GBD)[a]	
Disease	% DALYs	Disease	% DALYs
Ischemic heart disease	10.3	Ischemic heart disease	11.5
Anxiety disorders	8.5	Cerebrovascular disease	6.2
Cerebrovascular disease	6.6	Road traffic accidents	4.6
Visual impairments	6.4	Dementia	4.5
COPD (including asthma)	6.0	Trachea, bronchus, and lung cancer	3.7
Alcohol dependence	6.0	Unipolar major depression	3.7
Lung cancer	4.8	Osteoarthritis	3.5
Depression	4.4	Perinatal conditions	3.2
Hearing impairments	4.0	COPD	3.0
Diabetes	3.4	Diabetes	2.6
Total	60.2		46.5

Note. The burden of each disease is given as a percentage of the total number of DALYs. COPD = chronic obstructive pulmonary disease.
[a]From Murray and Lopez.[5]

column presents the average from the general practitioner registrations, with standard error as percentage of the mean. For all 4 diseases, the relative standard errors of the estimates, reflecting the differences between individual registrations, are substantial. The next column shows the (combined) disability weight with the relative standard error. Especially for acute sinusitis and atopic eczema, with a low disability weight, the relative standard errors are large. The last column shows the resulting relative standard errors for the YLDs. For 3 of the 4 examples, the relative standard error is approximately 33%. It appears that for heart failure and rheumatoid arthritis, the variation in YLDs largely reflects the variation in the prevalence data rather than the uncertainty in the disability weights. For acute sinusitis, the reverse is true: here, the relative standard error of the disability weight provides the largest source of uncertainty. Atopic eczema, finally, is an extreme case: both the prevalences and disability weights contribute substantially to the large standard error in YLDs.

Discussion

This report presents an estimation of the burden of disease for 48 important diseases and disorders in the Netherlands, largely on the basis of the DALY methodology as developed by Murray and Lopez.[5] The results clearly indicate the important contribution of both mortality and morbidity to the total burden of disease. The public health relevance of a specific disease depends heavily on which aspects of health are observed: morbidity, mortality, or the combination of both in DALYs. The study represents one of the first examples of such calculations that uses epidemiologic data as well as disability weights derived at the level of a single Western European country. In this context, emphasis has been placed on a number of methodological issues and their impact on the validity of the results.

The selection of diseases considered includes the most important categories on the basis of their share in overall mortality and/or morbidity (prevalence or incidence) in several registries. It therefore misses a substantial group of smaller disease entities. Consequently, the total numbers of YLLs, YLDs, and DALYs calculated are an underestimate of the complete burden of disease for the Netherlands. Upon closer examination, *ICD-9-CM* chapters such as those on genitourinary and gastrointestinal disorders are notably underrepresented in the selection (on the basis of mortality data). In terms of the 7 large groups (compare Figure 1), this may have caused a bias against the "other somatic disorders."

Regarding the presented numbers of YLDs and DALYs, a major source of uncertainty has its basis in the prevalence and incidence data. Three types of data sources were used: general practitioner registrations, national registries, and population surveys. For cancers and injuries, national registries were considered the most reliable source. For most psychiatric diseases and vision and hearing impairments, we applied data from population surveys because of an anticipated underestimate in medical registrations, given that not all people with diseases will ask for medical help. Estimates from population surveys, on the other hand, are most likely overestimates. To what extent the surplus prevalence detected in population surveys represents the less severe cases is a subject for further research. Surplus prevalence also has an impact on the disability weight. When the disability weight of, for example, hearing impairments is based on cases seen in medical practice, it might be too severe for hearing impairments detected in population surveys.

For most diseases, data from general practitioner registrations were used as the best available source. Because more than one general practitioner registration (3–5, depending on the disease) was used, we were able to estimate the

TABLE 3—Sensitivity Analysis for Selected Diseases

Disease	Mean Prevalence *(Incidence)* (SE)[a]	Mean Disability Weight (SE)[a]	Mean YLD (SE)[a]
Heart failure[b]	93 600 (22)	0.15 (8)	14 400 (23)
Acute sinusitis[c]	*433 100 (10)*	0.02 (29)	8 700 (31)
Atopic eczema[c]	238 100 (31)	0.07 (43)	16 700 (53)
Rheumatoid arthritis[d]	80 700 (27)	0.53 (9)	42 300 (29)

Note. Years lived with disability (YLDs) were calculated from prevalence (or incidence) data from 3 general practitioner registrations (from Ruwaard and Kramers[15]), and (combined) disability weights were based on data from Stouthard et al.[16]
[a]Standard error is expressed as a percentage of the mean (relative standard error).
[b]Heart failure was divided into 3 stages with disability weights of 0.06, 0.35, and 0.65, while the percentage of the prevalence in each stage was estimated as 78%, 11%, and 11%.
[c]Acute sinusitis (included in upper respiratory infections) and atopic eczema were not further subdivided.
[d]Rheumatoid arthritis was divided into 3 stages with disability weights of 0.21, 0.37, and 0.94, while the percentage of the prevalence in each stage was estimated as 10%, 60%, and 30%.

variance in the prevalence and its effect on the variance of the calculated YLDs. A few examples of this are given in Table 3, and more extensive documentation of this kind can be found elsewhere.[15] It appears that different registrations frequently offer diverging estimates of prevalence or incidence, which often cannot be easily explained from differences in the case definition or in the design of the registration.[15]

The validity of the applied disability weights is discussed by Stouthard et al.[16] They concluded that their study yielded positive indications with respect to the reliability and the validity of the disability weights elicited, considering the small differences between the valuation panels, the satisfactory internal consistency, and the similarity of the results to those of the GBD-1990 study. The largest concern with variations in the disability weights is that at the "mild" end of the disability scale, their impact on calculated YLDs is much larger than at the "severe" end. This is because the *relative* impact of a difference of, for example, 0.1 at the severe end is much smaller. In Table 3, this is illustrated by the large relative standard errors for acute sinusitis and atopic eczema compared with those for heart failure and rheumatoid arthritis.

Table 3 shows a few examples of how uncertainties in both epidemiologic data and disability weights can give large errors in YLD estimates. This is especially relevant in the case of disorders that are relatively mild and at the same time rather frequent, such as atopic eczema, but it applies also for visual and hearing impairments and for anxiety disorders. For some diseases, the uncertainty of the estimates is large enough to require caution in interpreting relatively small differences between disease categories. An implication for future research is that, especially for the group of mild disorders, the disability weights and the epidemiologic data have to be established in a common exercise, with a very strict case definition.

Whereas Murray and Lopez used an incidence–duration approach in the GBD-1990 study, we used a prevalence-based approach. The main difference is that the GBD-1990 study ascribed the burden to the new cases in a particular year; using prevalences, we describe the burden of disease on the basis of the present cases in 1 year. Our YLDs therefore refer to the actual disease burden in the population in 1994. The advantages of the incidence-based approach are that recent changes in incidence are taken into account and the calculations of the YLDs and YLLs are more comparable. A major disadvantage, however, is that this approach substantially increases data needs, such as disease duration and case fatality, which appear hard to meet.

The choice of whether to use prevalence- or incidence-based estimates of YLDs is, furthermore, dependent on the goal of the study. Prevalence-based calculations, for example, give more insight into present needs for health care, whereas incidence-based calculations are more appropriate when estimating health effects of prevention campaigns. If different types of information on one disease (such as prevalence, incidence, case fatality, and duration) are available, these can be linked in one model, called an incidence prevalence mortality (IPM) model. With this type of modeling, the available information can be made consistent in order to get the best estimates of incidence, prevalence, and mortality.

A comparison between our work and the GBD-1990 study for the EME is only partly possible, owing to the methodological differences discussed above and differences in the total number of diseases. The use of only 48 diseases in the Dutch study can explain the finding that the top 10 diseases in the Netherlands make up a higher percentage of the total number of DALYs lost than the top 10 in the EME. A further difference is the use by Murray and Lopez of standard life tables for the calculations of YLLs, whereas we used Dutch life tables. Since the life expectancy in the Netherlands is above the average for the EME, this may partly explain the relatively high ratio of calculated YLDs vs YLLs in our study (approximately 1.5, compared with less than 1 in the GBD-1990 EME study), although the incomplete coverage of both morbidity and mortality may also play a role here, as well as the relatively high burdens in terms of YLDs we found in the Netherlands for relatively mild but frequent diseases. A final reason for the differences between our study and the GBD-1990 EME study may be that the Netherlands is not necessarily representative of the EME in many details: mortality through road traffic accidents, for example, is substantially lower in the Netherlands than the European Union average.[18]

Comorbidity has generally not been dealt with in the disability weighting and the YLD calculations. This means that, in cases of comorbidity, disability weights were implicitly added up, which could in theory lead to weights exceeding 1 for complex comorbid situations at an individual level. Because it is not obvious whether having more conditions at the same time should be valuated as less or as more severe than the sum of the separate disability weights, and in view of the perspective of prioritization of diseases through DALYs, adding up weights seems an acceptable approach for the time being. One recent study on comorbidity and the disability-adjusted life expectancy, a measure related to the DALY, suggested that the effect on the final results of taking into account comorbidity might be rather insignificant compared with other uncertainties.[19]

The use of composite health outcome measures such as DALYs implies several normative choices—for example, the reference life table to be used and the valuation procedures. These choices have been extensively discussed not only in the literature on DALYs but also in the literature on a related composite measure, the quality-adjusted life-year (QALY).[5,14,20–22] An important feature of the DALY (and QALY) methodology is that choices and valuations are made explicit and are therefore open to discussion. Murray has recognized that simple comprehensive measures such as DALYs tend to be used as a norm by themselves, stating that "it is prudent to recognize the normative shadow that health measures cast and to try to reason carefully about their likely normative uses and the implications of such uses for the design of health indicators."[5(p3)]

We conclude that the DALY qualifies as a possibly useful tool in public health and that further development and application at the national level of the DALY approach should be supported. At the same time, this study has highlighted that even in a country like the Netherlands, with a fairly well-developed system of registrations and surveys, we still need improvement in epidemiologic data collection. From a public health perspective, one of the desirable uses for burden of disease studies is detection of disease-specific and overall trends in burden of disease within countries or populations over time. One issue that is still unresolved is the DALY measure's sensitivity to changes in a population's health over time. A prerequisite for high sensitivity is the precision or reliability of the DALY estimates, which also deserves attention in future research. □

Contributors

All of the authors contributed to the conception and design of the study and the analysis and interpretation of the data. The article was primarily written by J.M. Melse, with extensive comments and advice from the other authors.

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