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HEALTH TRANSITION IN EGYPT[1]

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This paper addresses the question of why there has been so little progress in the field of evaluation of health transition, and how can take into consideration the concept of Global Burden of Disease (GBD) to answer this question.

In order to capture the impact of both premature death and disability in a single measure, a common currency is required. Since the late 1940s, researchers have generally agreed that time is an appropriate currency: time (in years) lost through premature death, and time (in years) lived with a disability. A range of such time-based measures has been developed in different countries, many of them variants of the so-called Quality-Adjusted Life Year or QALY. For the Global Burden of Disease (GBD), an internationally standardized form of the QALY has been developed, called the Disability-Adjusted Life Year (DALY). The DALY expresses years of life lost to premature death and years lived with a disability of specified severity and duration. One DALY is thus one lost year of healthy life. Here, a "premature" death is defined as one that occurs before the age to which the dying person could have expected to survive if he was a member of a standardized model population with a life expectancy at birth equal to that of the world's longest-surviving population in Japan. In addition to DALY, the GBD project developed another summary measure, the Disability-Adjusted Life Expectancy (DALE), to provide a comprehensive assessment of the global burden of disease and injury. Both these summary measures of population health (SMPH) combine information on the impact of premature death and of disability and other non-fatal health outcomes.

Key words: Egypt – Health Transition – GBD – DALE

I. Introduction

In general, statistics on the health status of populations suffer from several limitations that reduce their practical value to policy-makers:

- First, they are partial and fragmented. In many countries even the most basic data—the number of deaths from particular causes each year— are not available. Even where

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mortality data are available, they fail to capture the impact of non-fatal outcomes of disease and injury, such as dementia or blindness, on population health.

- Second, estimates of the numbers died or affected by particular conditions or diseases may be exaggerated beyond their demographically plausible limits by well-intentioned epidemiologists who also find themselves acting as advocates for the affected populations in competition for scarce resources. If the currently available epidemiological estimates for all conditions were right, some people in a given age group or region would have to die twice over to account for all the deaths that are claimed.
- Third, traditional health statistics do not allow policy-makers to compare the relative cost-effectiveness of different interventions, such as, for example, the treatment of ischaemic heart disease versus longterm care for schizophrenia. At a time when people's expectations of health services are growing and funds are tightly constrained, such information is essential to aid the rational allocation of resources.

The GBD set out to address these problems with three explicit aims:

1. to incorporate non-fatal conditions into assessments of health status;
2. to disentangle epidemiology from advocacy in order to produce objective, independent and demographically plausible assessments of the burdens of particular conditions and diseases; and.
3. to measure disease and injury burden in a currency that can also be used to assess the cost-effectiveness of interventions, in terms of the cost per unit of disease burden averted.

Interest in summary measures relates to a range of potential uses. Murray, Salomon and Mathers (2000) identified eight of these:

1) Comparing the health of one population to the health of another population.
2) Comparing the health of the same population at different points in time.
3) Identifying and quantifying overall health inequalities within populations.
4) Providing appropriate and balanced attention to the effects of non-fatal health outcomes on overall population health.
5) Informing debates on priorities for service delivery and planning.
6) Informing debates on priorities for research and development in the health sector.
7) Improving professional training curricula in public health.
8) Analyzing the benefits of health interventions for use in cost-effectiveness analyses.

The burden of disease methodology provides a way to link information at the population level on disease causes and occurrence to information on both short-term and long-term health outcomes, including impairments, functional limitations (disability), restrictions in participation in usual roles (handicap), and death.

Given WHO's needs for annual life table estimates as part of the continuous assessment of health system performance, and a preference for a model life table system based on a modification of the Brass logit system, rather than other families of model life tables.

Beginning with the year 1999, WHO began making annual life tables for all Member States. These life tables have several uses and form the basis of all WHO's estimates about mortality patterns and levels worldwide. These life tables, such as Tables 3 and 4, provide the base, used here, to construct the disability adjusted life years (DALYs) and disability adjusted life expectancy (DALE), which represent the basic indicators of population health transition.

DALYs are a gap measure; they measure the gap between a population's actual health and some defined goal, while DALE belongs to the family of health expectancies, summarizing the expected number of years to be lived in what might be termed the equivalent of "full health". Both DALE and DALYs require a number of social value choices relating among other things, to the valuation of time spent in states of health worse than ideal health, the definition of an implied norm for population health, and the weighting of years of life lived at different ages.

It is important to note that the mortality strata were defined in terms of 1999 mortality estimates published in the World Health Report 2000 and some countries would be placed in different mortality strata now if these criteria were reapplied using latest mortality estimates. Due to improvements in child mortality over recent years, Egypt meets criteria for inclusion in the East Mediterranean subregion (EmrB) with low child and adult mortality instead of subregion EmrD.

Although data from Egypt for the year 2000, as shown in Table (2), was near complete vital registration (> 80%), it contained high proportions of deaths coded to symptoms and ill defined conditions, as well as to conditions such as heart failure, and cardiac arrest, which are essentially not underlying causes of death. Hence, the model-based prediction was used to find broad cause proportionate distribution by age and sex, and applied the cause specific mortality structure from the country data, after

II.METHODS AND MATERIALS

The concept of Disability-Adjusted Life Expectancy, or DALE, is applying for Egypt, as a primary summary measure of population health. DALE measures the equivalent number of years of life expected to be lived in full health, or healthy life expectancy. In constructing the estimates of Egypt, it is sought to address some of the methodological challenges regarding comparability of the health status data collected.

Household surveys including a valuation module were conducted in fourteen countries: China, Colombia, Egypt, Georgia, India, Iran, Lebanon, Indonesia, Mexico, Nigeria, Singapore, Slovakia, Syria and Turkey. Data on nearly 500,000 health state valuations from over 46,000 respondents were used to develop average global health state valuations for the calculation of HALE. Health state valuations quantify departures from perfect health, *i.e.*, the reductions in health associated with particular health states. It is important to emphasize that these weights *do not* measure the quality of life of people with disabilities and *do not* measure the value of different people to society.

Murray, Salomon and Mathers (2000) proposed two other desirable attributes of summary measures that are to be used to inform policy discussions. These are not attributes based on arguments about whether a population is healthier than another but rather on practical considerations:

1. Summary measures should be comprehensible and feasible to calculate for many populations. Comprehensibility and complexity are different. Life expectancy at birth is a complex abstract measure but is easy to understand. Health expectancies are popular because they are also easily understood.
2. Summary measures should be linear aggregates of the summary measures calculated for any arbitrary partitioning of sub-groups. Many decision-makers, and very often the public, desire information that is characterized by this type of additive decomposition. In other words, they would like to be able to answer what fraction of the summary measure is related to health events in the poor, in the uninsured, in the elderly, in children, and so on.

On the basis of a simple survivorship curve, SMPH can be divided broadly into two families: health expectancies and health gaps. The bold curve in Figure (1) is an example of a survivorship curve S(x) for a hypothetical population. The survivorship curve indicates, for each age x along the x-axis, the proportion of an initial birth cohort that will remain alive at that age. The area under the survivorship function is divided into two components, A which is time lived in full health and B which is time lived at each age in a health state less than full health. The familiar measure of life expectancy at birth is simply equal to A+B (the total area under the survivorship curve. A health expectancy is generally of the form:

$$\text{Health expectancy} = A + f(B) \quad \text{......................................} \quad (1)$$

where $f(.)$ is a function that weights time spent in B by the severity of the health states that B represents. When a set of health state valuations are used to weight time spent in health states worse than ideal health, the health expectancy is referred to as a health-adjusted or disability adjusted life expectancy (DALE). Another type of health expectancy is exemplified by disability-free life expectancy in which time spent in any health state categorized as disabled is assigned arbitrarily a weight of zero, and time spent in any state categorized as not disabled is assigned a weight of one (i.e., equivalent to full health).

To calculate total DALYs for a given condition in a population, years of life lost (YLLs) and years lived with disability of known severity and duration (YLDs) for that condition must each be estimated, and then the total summed. For example, to calculate DALYs incurred through road traffic accidents, add the total years of life lost in fatal road accidents and the total years of life lived with disabilities by survivors of such accidents.

Murray and Lopez published disability-adjusted life expectancy (DALE) estimates for the eight regions of the world based on the estimates of severity-weighted disability prevalence developed for the non-fatal component of disease and injury burden. As a summary measure of the burden of disability from all causes in a population, DALE has two advantages over other summary measures. The first is that it is relatively easy to explain the concept of an equivalent "healthy" life expectancy to a non-technical audience. The increasing popularity of health expectancy indicators among policy makers has been documented (Van de Water et al. 1996; Barendregt et al. 1998). The second is that DALE is measured in units (expected years of life) that are meaningful to and within the common experience of non-technical audiences (unlike other indicators such as health gaps, mortality rates or incidence rates).

In contrast to health expectancies, health gaps quantify the *difference* between the actual health of a population and some stated norm or goal for population health. The health goal implied is for everyone in the entire population to live in ideal health until the age indicated by the vertical line enclosing area C at the right[1]. In the specific example shown, the normative goal has been set as survival in full health until age 100. By selecting a normative goal for population health, the gap between this normative goal and current survival, area C, quantifies premature mortality.

A health gap is generally of the form:

$$\text{Health gap} = C + g(B) \qquad (2)$$

where $g()$ is a function that weights time spent in B by the severity of the health states that B represents. Note that because health gaps measure a negative entity, namely the gap between current conditions and some established norm for the population, the weighting of time spent in B is on a reversed scale as compared to the weighting of time spent in B for a health expectancy. More precisely, full health is 1

[1] Figure 1 graphically illustrates the magnitude of both health expectancies and health gaps only when a population has a stable distribution with a zero population growth rate. In practice, health expectancies are not sensitive to differences in the age structure of different populations. Health gaps are usually reported in absolute terms so that health gaps are sensitive to variations in the age distribution of different populations although age independent forms of health gaps can be formulated.

in a health expectancy, whereas death or a state equivalent to death is 1 in a health gap. Because health gaps measure the distance between current health conditions and a population norm for health, they are clearly a normative measure.

Years of life lost measures are all measures of a mortality gap, or the area between the survivorship function and some implied target survivorship function (area C in Figure 1).

Health expectancies can be categorized into two main classes: those that use dichotomous health state weights and those that use health state valuations for an exhaustive states. The first class includes:

a) Disability-free life expectancy:

This health expectancy gives a weight of 1 to states of health with no disability (above an explicit or implicit threshold) and a weight of 0 to states of health with any level of disability above the threshold. Other examples of this type of health expectancy include active life expectancy, independent life expectancy and dementia-free life expectancy.

b) Life expectancy with disability:

This is an example of a health expectancy which gives 0 weight to all states of health apart from one specified state of less than full health (in this case, disability above a certain threshold of severity). If health state is 'moderate disability', then the area under the survival curve, corresponding to the specific health state, represents life expectancy with moderate disability. Other examples of this type of health expectancy include handicap expectancy, severe handicap expectancy and unhealthy life expectancy.

The seconed class includes:

a) Health-adjusted life expectancies:

These have been calculated for Canada and Australia using population survey data on the prevalence of disability at four levels of severity together with more or less arbitrary severity weights

b) Disability-adjusted life expectancy:

This was calculated for the Global Burden of Disease. Study using disability weights reflecting social preferences for seven severity levels of disability.

Although health states form a continuum, in practice they are generally conceptualised and measured as a set of mutually exclusive and exhaustive discrete states ordered on one or more dimensions. The health state can be enumerated using a discrete index (h), then the disability-adjusted life expectancy can be calculated as:

$$DALE_x = \sum_h \int_x^L w_h(u) * S_h(u)du \qquad \text{.........(3)}$$

where u represents age and the integral is over ages from x onwards. If the weight w_h for state h is independent of age u, then

$$DALE_x = \sum_h \left(w_h * \int_x^L s_h(u)du \right) = \sum_h w_h * HE_{hx} \qquad (4)$$

where HE_{hx} is the health state expectancy at age x for years lived in state h.

In terms of the four health states illustrated in Figure (1), if $HE_{1,0}$ to $HE_{4,0}$ are the health state expectancies at birth for each of the four states, and age-independent weights w_2, w_3, w_4 (less than 1) were given to the three states of less than full health, then the disability-adjusted life expectancy at birth and total life expectancy at birth are given by:

$$DALE_0 = HE_{1,0} + w_2 * HE_{2,0} + w_3 * HE_{3,0} + w_4 * HE_{4,0} \qquad (5)$$

$$LE_0 = HE_{1,0} + HE_{2,0} + HE_{3,0} + HE_{4,0} \qquad (6)$$

In the mid-1990s, Reves developed a set of recommendations for terminology that was widely adopted (Mathers C.D., et al., 1994). With the development of health gaps measures in the 1990s, there has been some shift in the use of these terms, and health expectancy is now used to denote the general class of summary measures that relate to the area under the survival curve. The terminology used in this section is the revised terminology proposed by Mathers:

1- *Health expectancy (HE)*: Generic term for summary measures of population health that estimate the expectation of years of life lived in various health states.

2- *Health state expectancy:* Generic term for health expectancies which measure the expectation of years lived in a single specified health state (eg. Disability-free).

3- *Disability-adjusted life expectancy* (DALE): General term for health expectancies which estimate the expectation of equivalent years of good health based on an exhaustive set of health states and weights defined in terms of health state valuations. Health-adjusted life expectancy (HALE) is a synonym for DALE.

Valuing health states In order to use time as a common currency for years of life lived in various states of health and for time lost due to premature mortality, the value time lived in nonfatal health states must be numerically valued. The health state valuations (or *disability weights*) used in DALY and DALE calculations represent societal preferences for different health states. They range from 0 representing a state of good or ideal health (preferred to all other states) to 1 representing states equivalent to being dead. These weights do not represent the lived experience of any disability or health state, or imply any societal value of 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.

The disease-specific approach is used to develop the best possible initial (prior) estimates of weighted disability prevalence by age and sex for Egypt. These estimates are based on preliminary burden of disease analyses at country level which build on condition-specific epidemiological information to the maximum extent possible. The following steps describe in detail how these estimates were developed.

Step 1. As part of its annual assessment of world health in the World Health Report, WHO is updating and revising its estimates of disease burden for the 14 mortality subregions of the world. This involves carrying out detailed and comprehensive reviews of the incidence, prevalence, duration, and case fatality in all the regions of the world for each of 109 major disease and injury causes of mortality and disability by age group and sex.

Step 2. WHO has prepared estimates of numbers of deaths for each of its 191 Member States according to sex, age group (0, 1-4, then 5-year age groups to 85+) and 130 disease and injury causes (covering all causes of disease and injury). These estimates are used to calculate YLL by sex, age group and detailed causes for Egypt.

Step 3. This country-level mortality data (Step 2), some country level epidemiological data and regional burden of disease estimates (Step 1) were then used to develop country-level estimates for YLD and total DALYs by sex, 5 year age group, and detailed cause as follows.

For specific disease and injury causes where mortality is responsible for a significant proportion of the total burden (YLD/YLL ratio less than 5), regional estimates of YLD/YLL ratios by age and sex together with country-level estimates of YLL were used to estimate country-level YLD. This process ensures that country-specific knowledge on the epidemiology of the disease (as reflected in the country-level mortality estimates of that disease) is used to adjust the regional-level patterns of disability due to that cause.

For specific disease and injury causes where mortality is not responsible for a significant proportion of the total burden (YLD/YLL ratio is 5 or higher), regional estimates of YLD rates per 1,000 population by age and sex were used together with country-level population distribution estimates and estimates of health expenditure per capita to make first estimates of the resulting YLD for each country. For some diseases, notably cancers, major depression and chronic respiratory conditions, available country-specific epidemiological estimates were also examined.

In order to estimate disability prevalence at population level, it is also necessary to estimate the YLD associated with residual categories of disease and injury such as 'Other chronic respiratory diseases' or 'Other malignant neoplasms'.

Step 4. For Egypt, the incidence of YLD is used classified by age, sex and detailed cause (Step 3) to estimate undiscounted and un-age-weighted prevalence YLD by 5 year age group, sex and detailed cause. The method for conversion of incidence YLD to prevalence YLD used was dependent on the average duration of condition as follows:

Short duration (<5 years): Prevalent YLD are equal to incident YLD

Moderate duration (5 years to 50% of remaining life expectancy):

It is assumed that the incident YLDs are evenly distributed across the age interval a to a+L, where a is average age of onset and L is average duration.

Long duration (50% or more of remaining life expectancy):

Then, a life table is constructed, for years lived with condition using the Egypt life table and proportionately increasing mortality rates at all ages to match remaining life expectancy to the average duration of condition. The L_x (years lived) column of the resulting life table is used to distribute incident YLD across age groups.

Step 5. Adjustment for comorbidity. The total prevalent YLD per 100 population is used as a severity-weighted disability prevalence measured as a percentage of the population of that age. However, summation over all conditions of the prevalence YLD calculated in Step 4 would result in overestimation of disability prevalence because of comorbidity between conditions. There is a correction for independent comorbidity between major condition groups (these approximately correspond to the Chapters of the International Classification of Diseases) as follows:

$$PYLD_{s,x} = 1 - \prod_{g}(1 - PYLD_{s,x,g}) \qquad (7)$$

where $PYLD_{s,x,g}$ is the prevalence YLD per 100 population for sex s, age x and cause g. The resulting PYLD per 100 population for sex s, age x gives the severity-weighted prevalence of disability by age and sex.

Using the WHO database of diseases, the analysis of many more disease stages, severity levels and sequelae was done. For some conditions, numbers of incident cases are available directly from prevalence data computed using a software program called DISMOD© to model incidence and duration from estimates of prevalence, remission, case fatality and background mortality.

In order to estimate the prevalence of disability (non-fatal health) by five year of the health status data collected, Sullivan's method to calculate DALE from posterior disability estimates plus country life tables was used. After conducting several validity and reliability checks, the analysis confirmed a latent dimension of disability that is common across population survey data and estimated the level of disability. The cumulative distribution of disability prevalence by severity is approximately exponential according to the detailed analyses carried out for the Global Burden of Disease study. The distributions of latent health factor scores derived from the analysis of country health surveys were also generally exponential. The distribution of disability by severity level (or disability weight) can thus be approximately described by the two parameters of exponential distribution as follows:

$$d(x) = \frac{\alpha}{\beta} e^{-\frac{x}{\beta}} \qquad (8)$$

where x is the disability weight (severity) measured on a scale where 1 represents good health and 0 represents a state equivalent to death. The mean of this distribution is:

$$\bar{d} = \alpha \times \beta \qquad (9)$$

The parameter α is readily interpreted as the proportion of the population with disability (with non-zero disability weight) and β as the average disability weight among the people with disability.

Sullivan's method was used to compute DALE for Egypt from the country life table and the severity-weighted prevalence estimates. Sullivan's method involves using the observed prevalence of disability at each age in the current population (at a given point of time) to divide the hypothetical years of life lived by a period life table cohort at different ages into years with and without disability. The method is illustrated in Table 1

Table (1): Health state life table (illustrative table)

Age	Ordinary life table			Disability prevalence (%)	Years with disability	Years without disability	LED LE with disability	DFLE Disability -free LE
	Survivors l_x	Years lived L_x	Expectation of life e_x					
0	100000	496210	74.98	4.5	22130	474080	16.60	58.38
5	99134	495425	70.63	9.6	47506	447919	16.52	54.11
10	99045	495018	65.69	8.6	42568	452450	16.05	49.64
15	98940	493916	60.76	5.7	28100	465816	15.64	45.12
20	98572	491448	55.98	7.6	37433	454015	15.41	40.56
25	97997	488469	51.29	8.5	41623	446846	15.12	36.17
30	97383	485285	46.60	10.6	51280	434005	14.79	31.81
35	96722	481816	41.90	12.2	59013	422803	14.36	27.54
40	95988	477781	37.20	14.3	68247	409534	13.86	23.34
45	95079	472220	32.53	17.9	84507	387713	13.27	19.26
50	93701	463324	27.97	23.5	108766	354558	12.57	15.40
55	91452	448652	23.59	30.9	138780	309872	11.68	11.90
60	87702	424469	19.48	41.6	176738	247731	10.60	8.88
65	81656	386806	15.73	44.0	170265	216541	9.22	6.50
70	72512	332217	12.38	58.3	193526	138691	8.04	4.34
75	59796	259645	9.45	59.6	154714	104931	6.51	2.94
80	43550	173081	7.02	73.2	126672	46409	5.39	1.63
85	25802	132424	5.13	81.5	107916	24508	4.18	0.95

Notes: First four columns are from a standard life table for a population.

l_x is the number of survivors at age x in the hypothetical life table cohort.

L_x is the number of years of life lived by the life table cohort between ages x and $x+5$.

$prev_x$ is the prevalence of disability between ages x and $x+5$ in the population.
Years lived with disability $YD_x = L_x * prev_x$,
Years lived without disability $YWD_x = L_x * (1-prev_x)$
$DFLE_x$ = Sum of years lived without disability for ages x and above, divided by l_x
DLE_x = Sum of years lived with disability for ages x and above, divided by l_x

DALE can be calculated using the same method as computed in Table 4 and Table 5 where disability prevalence is replaced by severity-weighted disability prevalence as shown in Table 3.
Using standard notation for the country life table parameters, the DALE is calculated at age x as follows:
D_x Severity-weighted prevalence of disability between ages x and $x+5$
YD_x $= L_x * D_x$ Equivalent years of healthy life lost due to disability between Ages x and $x+5$
YWD_x $= L_x * (1 - D_x)$ Equivalent years of healthy life lived between ages x and $x+5$
L_x is the total years lived by the life table population between ages x and $x+5$.
DALE at age x is the sum of YWD_i from $i = x$ to w (the last open-ended age interval in the life table) divided by l_x (survivors at age x):

$$DALE_x = \left(\sum_{i=x}^{w} YWD_i\right) / l_x$$

$$DLE_x = \left(\sum_{i=x}^{w} YD_i\right) / l_x = LE_x - DALE_x$$

DLE_x, the equivalent years of healthy life lost due to disability, is the sum of YD_i from $i = x$ to w
divided by l_x (survivors at age x).

III.RESULTS

Using the methods outlined in the previous Section, the estimated healthy life expectancy (DALE) is calculated for males and females in Egypt. These estimates of healthy life expectancy are based on country-specific estimates of mortality, cause of death patterns, epidemiological analyses and health survey data where available.

The relative contributions of diseases and injuries to variations in DALE are best summarized in terms of the loss of healthy life measured in DALYs. The World Health Report provides detailed estimates of DALYs for over 100 disease and injury categories for the 14 mortality subregions. The leading causes of DALYs worldwide, EMRO B and EMRO D sub-regions are shown in Tables 7, 8 and 9 respectively. Thus while perinatal conditions, HIV/AIDS and lower respiratory infections are the three leading causes of DALYs worldwide, Ischaemic heart disease, Unipolar major depression, and Perinatal conditions are the three leading causes of DALYs in EMRO B (including Egypt).

Several important conclusions emerge using this GBD's approach. For example, Table 5 and Table 6 show that it can be verified that the Egyptian male with life expectancy 66 years (2002), there are 7.4 years are spent, in average, in disability or around 11.4% of normal life span; and the Egyptian female with life expectancy 69 years, there are 8.8 years spent, in average, in disability or around 12.8% of normal life span. The global figure shows that, in more developed countries with life expectancies over 70 years around 8 years are spent on average in disability or around 11.5% of normal life span, and in least developed countries with low life expectancy such as in parts of Africa the years spent in disability increase to 11 years or roughly 25 % of normal life span.

IV.DISCUSSION

The GBD has sought to develop a measure based on explicit and transparent value choices that may be readily debated and modified. Overall, the DALY has a strongly egalitarian flavour. It is built on the principle that only two characteristics of individuals that are not directly related to their health—their age and their sex—should be taken into consideration when calculating the burden of a given health outcome in that individual. Other characteristics, such as socioeconomic status, or level of education, are not considered, so, for example, years of healthy life lived by the director of a bank are regarded as no more valuable than those lived by a poor rural peasant. In the remainder of this section, the social choices that affect the social choices that affect the DALY are each discussed briefly.

The Global Burden of Disease study (GBD) has involved an extraordinarily large volume of data - on 483 separate sequelae of 107 diseases and injuries, and 14 million death certificates - has been subjected to rigorous analysis using both newly developed and well established methods.

In accordance with the GBD's egalitarian principles, the study assumes a standard life table for all populations, with life expectancies at birth fixed at 82.5 years for women and 80 years for men. A standard life expectancy allows deaths in all communities at the same age to contribute equally to the burden of disease. Alternatives, such as using different life expectancies for different populations that more closely match their actual life expectancies, interfere with the egalitarian principle. For example, if a 35 year-old woman dies in childbirth in an African country where she might have expected to live another 30 years, her years of life lost would be deemed unfairly to be fewer than those for a 35 year-old woman who dies in childbirth in Japan, when she might otherwise have expected to live another 48 years. Life expectancy is not equal for men and women. Accordingly, the GBD has given men a lower reference life expectancy than women. However, since much of the difference between men and women is determined by men's higher exposure to various risks such as tobacco and occupational injury, rather than purely biological differences, this choice is arguably a form of discrimination against men and could be modified in future revisions of the DALY.

Most health expectancies satisfy the first attribute. However, they cannot be additively decomposed in respect of causes or population sub-groups. Disability-adjusted life expectancies are additively decomposable into health expectancies for specified levels of disability severity. This form of decomposition may be useful in understanding which levels of disability severity are contributing most to changes in population health.

Health state expectancies should be understood as a decomposition of a DALE summary measure than as SMPH in themselves. This interpretation is consistent with the usual ways in which families of health state expectancies are presented for a population (Robine J.M., 1994; Mathers C.D., 1996).

In general, health gaps can be decomposed into the contribution of various causes in a more intuitive and easily communicated fashion than health expectancies. DALYs are additive across causes to give the total health gap for a population. Disability-adjusted life expectancy and a health gap measure such as the DALY thus fulfill different needs for SMPH to summarise and report on trends and achievements in population health across countries.

V. REFERENCES

Ahmad O, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. (2000), Age standardization: the new WHO world standard population. Geneva, World Health Organization, (GPE Discussion Paper No. 31).

Coale, A. and Guo, G. (1990), New regional model life tables at high expectation of life (addendum to (1989) paper). *Population Index*, **56**, 27–41.

Mathers C, Sadana R, Salomon J, Murray CJL, Lopez AD (2000), *Estimates of DALE for 191 countries: methods and results.* Geneva, World Health Organization, 2000 (GPE Discussion Paper No. 16).

Mathers CD (1996). Trends In Health Expectancies In Australia 1981-1993. Journal of the Australian Population Association 13(1): 1-16.

Mathers CD (1999b), Health expectancies: an overview and critical appraisal, Global Conference on Summary Measures of Population Health, World Health Organisation, Marrakech, December, 1999.

Mathers CD, Robine JM, Wilkins R (1994). Health expectancy indicators: recommendations for terminology.. In: C.D. Mathers, J. McCallum, J.M. Robine (eds), Advances in health expectancies: proceedings of the 7th meeting of the international network on health expectancy (REVES), Australian Institute of Health and Welfare, Canberra 1994.

Murray CJL and Lopez AD, eds. (1996), *The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2030,* Global Burden of Disease and Injury Series, Vol.1, Harvard University Press.

Murray CJL, Salomon J, Mathers C (1999), *A critical review of summary measures of population health,* Geneva, World Health Organization, 2000 (GPE Discussion Paper No. 2).

Murray, CD Mathers, AD Lopez, J Salomon, R Lozano (1999), *Summary measures of population health,* Geneva, World Health Organization (under preparation).

Myers, G. (1995), Comparative study of mortality trends among older persons in developed countries. In *Health and mortality among elderly populations* (ed. G. Casselli and A. Lopez). Clarendon Press, Oxford.

Robine JM (1994), Disability-free life expectancy trends in France, international comparison, In Mathers C, McCallum J, Robine JM (eds.) Advances in health expectancies, Australian Institute of Health and Welfare, Canberra.

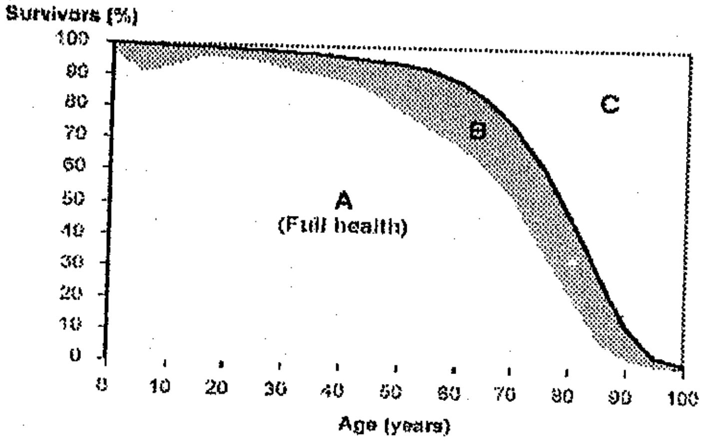
Robine, J.M., Mormiche, P., and Sermet, C. (1998), Examination of the causes and of the mechanisms of the increase in disability-free life expectancy. *Journal of Aging and Health*, **10**, 171–91.

Ruzicka, L.T. (1986), *'The elusive path of mortality transition'* in H. Hansluwka, A.D.Lopez, Y. Porapakkham and P. Prasartkul (eds), New Developments in the Analysis of Mortality and Causes of Death, World Health Organization, Geneva, and Mehidol University.

Verbrugge, Lois M., (1997), "A Global Disability Indicator," Journal of Aging Studies, Vol. 11, No. 4, pp. 337-62.

WHO (1992*a*), *Global health situation and projections, estimates.* Division of Epidemiological Surveillance and Health Situation and Trend Assessment, WHO, Geneva.

Figure (1): Survivorship function for a population



Source: WHO, Global Programme on Evidence for Health Policy Working Paper No. 16, 2000.

Table (2): Data sources and methods for estimates of all cause mortality by age and sex[1]

Member State	Method for 2002	Vital registration years	Other sources
Egypt	Project vital with adjustment	1950-1981, 1983-2000	Census 76, Census 86, Contraceptive Prevalence Survey 84, Demographic and Health Survey 92, Demographic and Health Survey 95, Demographic and Health Survey 2000, Fertility Survey 77, Maternal and Child Health Survey 91 and World Survey 80.

[1] Source: Extracted from WHO, Burden of Disease, Discussion Paper no.54, Annex Table 6, 2003.

Table (3): Egypt life table, males, 2000

age	$_nM_x$	$_nq_x$			l_x			$_nd_x$	$_nL_x$	e_x			Actual Deaths	Actual Population
			Percentiles			Percentiles					Percentiles			
		Mean	$2_{1/2}$	$97_{1/2}$	Mean	$2_{1/2}$	$97_{1/2}$			Mean	$2_{1/2}$	$97_{1/2}$		
<1	0.0394	0.0381	0.0347	0.0414	100,000	100,000	100,000	3,806	96,574	65.4	64.6	66.3	33,066	838,920
1-4	0.0033	0.0129	0.0120	0.0139	96,194	95,856	96,531	1,245	381,787	67.0	66.3	67.7	10,617	3,257,091
5-9	0.0010	0.0049	0.0046	0.0053	94,949	94,551	95,349	469	473,572	63.8	63.1	64.6	3,951	3,989,177
10-14	0.0009	0.0044	0.0041	0.0047	94,480	94,049	94,909	418	471,355	59.2	58.5	59.8	3,718	4,193,258
15-19	0.0012	0.0059	0.0054	0.0063	94,062	93,603	94,517	553	468,928	54.4	53.7	55.1	4,572	3,878,862
20-24	0.0012	0.0062	0.0057	0.0066	93,509	93,013	94,001	580	466,097	49.7	49.1	50.4	4,014	3,227,983
25-29	0.0014	0.0070	0.0065	0.0075	92,930	92,395	93,462	650	463,022	45.0	44.4	45.7	3,766	2,681,008
30-34	0.0019	0.0094	0.0087	0.0101	92,279	91,703	92,855	868	459,227	40.3	39.7	41.0	4,670	2,472,089
35-39	0.0024	0.0121	0.0112	0.0129	91,412	90,781	92,046	1,104	454,298	35.7	35.1	36.3	5,275	2,170,157
40-44	0.0039	0.0193	0.0179	0.0206	90,307	89,610	91,014	1,740	447,187	31.1	30.5	31.7	7,820	2,009,883
45-49	0.0071	0.0349	0.0324	0.0373	88,568	87,770	89,384	3,088	435,117	26.6	26.1	27.2	11,906	1,677,626
50-54	0.0112	0.0546	0.0508	0.0584	85,479	84,519	86,478	4,666	415,733	22.5	22.0	23.1	13,478	1,200,975
55-59	0.0169	0.0810	0.0755	0.0866	80,814	79,641	82,059	6,542	387,713	18.7	18.2	19.2	14,208	841,980
60-64	0.0267	0.1251	0.1168	0.1334	74,271	72,812	75,809	9,291	348,130	15.1	14.6	15.6	18,453	691,421
65-69	0.0424	0.1915	0.1790	0.2031	64,980	63,097	66,927	12,447	293,786	11.9	11.5	12.3	22,597	533,561
70-74	0.0679	0.2904	0.2723	0.3068	52,534	50,293	54,823	15,254	224,535	9.1	8.8	9.5	24,314	357,895
75-79	0.1100	0.4314	0.4085	0.4523	37,280	34,990	39,696	16,082	146,196	6.8	6.6	7.1	23,247	211,335
80-84	0.1637	0.5809	0.5582	0.6017	21,198	19,377	23,361	12,314	75,206	5.1	4.9	5.2	16,006	97,750
85-89	0.2579	0.7840	0.7669	0.7998	8,884	7,771	10,288	6,965	27,007	3.6	3.5	3.7	7,432	28,816
90-94	0.3715	0.8785	0.8669	0.8892	1,919	1,559	2,398	1,686	4,537	2.6	2.6	2.7	1,388	3,736
95-99	0.4895	0.9915	0.9896	0.9930	233	173	319	231	472	2.0	2.0	2.0	108	220
100+	0.5898	1	1	1	2	1	3	2	3	1.7	1.6	1.7	3	5
All Ages													234,609	34,363,548

Table (4): Egypt life table, females, 2000.

age	$_nM_x$	$_nq_x$			l_x			$_nd_x$	$_nL_x$	e_x			Actual Deaths	Actual Population
			Percentiles			Percentiles					Percentiles			
		Mean	$2_{1/2}$	$97_{1/2}$	Mean	$2_{1/2}$	$97_{1/2}$			Mean	$2_{1/2}$	$97_{1/2}$		
<1	0.0370	0.0358	0.0325	0.0393	100,000	100,000	100,000	3,583	96,775	69.1	68.1	70.0	29,857	805,534
1-4	0.0035	0.0138	0.0128	0.0150	96,417	96,071	96,746	1,331	382,473	70.7	69.9	71.4	10,318	3,103,335
5-9	0.0008	0.0039	0.0036	0.0042	95,086	94,688	95,484	372	474,498	67.6	65.9	68.3	2,990	3,811,812
10-14	0.0007	0.0034	0.0031	0.0037	94,714	94,299	95,132	319	472,770	62.9	62.2	63.5	2,701	3,999,342
15-19	0.0008	0.0040	0.0037	0.0044	94,394	93,959	94,829	382	471,017	58.1	57.4	58.8	2,983	3,681,891
20-24	0.0008	0.0042	0.0039	0.0046	94,012	93,550	94,470	399	469,066	53.3	52.6	54.0	2,574	3,029,867
25-29	0.0011	0.0055	0.0051	0.0059	93,614	93,121	94,096	512	466,791	48.5	47.9	49.2	2,747	2,505,554
30-34	0.0012	0.0061	0.0057	0.0067	93,102	92,569	93,616	571	464,085	43.8	43.1	44.4	2,854	2,329,254
35-39	0.0017	0.0084	0.0078	0.0091	92,532	91,953	93,079	780	460,709	39.0	38.4	39.7	3,500	2,067,910
40-44	0.0025	0.0124	0.0115	0.0135	91,752	91,111	92,344	1,140	455,910	34.3	33.7	35.0	4,926	1,970,223
45-49	0.0041	0.0202	0.0187	0.0219	90,612	89,883	91,271	1,832	443,481	29.7	29.2	30.4	6,940	1,699,120
50-54	0.0074	0.0364	0.0336	0.0395	88,780	87,911	89,543	3,236	435,812	25.3	24.8	25.9	9,332	1,253,816
55-59	0.0120	0.0583	0.0538	0.0630	85,544	84,437	86,517	4,983	415,265	21.2	20.7	21.7	10,973	914,869
60-64	0.0180	0.0861	0.0797	0.0927	80,561	79,119	81,862	6,938	385,491	17.3	16.9	17.8	14,128	784,874
65-69	0.0290	0.1352	0.1256	0.1447	73,623	71,782	75,334	9,954	343,231	13.7	13.3	14.2	18,634	642,547
70-74	0.0479	0.2140	0.1993	0.2277	63,669	61,409	65,851	13,626	284,263	10.5	10.1	10.9	22,109	461,274
75-79	0.0855	0.3521	0.3299	0.3723	50,044	47,522	52,600	17,622	206,164	7.6	7.4	8.0	24,121	282,193
80-84	0.1479	0.5398	0.5136	0.5634	32,422	30,074	35,002	17,500	118,360	5.4	5.2	5.7	20,150	136,282
85-89	0.2352	0.7405	0.7193	0.7594	14,922	13,285	16,892	11,049	46,986	3.9	3.8	4.0	10,553	44,873
90-94	0.3439	0.8464	0.8319	0.8594	3,872	3,211	4,741	3,277	9,530	2.8	2.7	2.9	2,373	6,900
95-99	0.4625	0.9685	0.9634	0.9730	595	452	797	576	1,246	2.1	2.1	2.2	235	503
100+	0.5718	1	1	1	19	12	29	19	33	1.7	1.7	1.8	8	14
All Ages													205,516	33,520,928

Table (5): Health state life table for males, Egypt, 2000

age	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	e_x	Disability prevalence	Years with disability	Years without disability	LED with disability	DFLE without disability	Actual Deaths	Actual Population
<1	0.0394	0.0381	100,000	3,806	96,574	65.4	4.5	4346	92228	14.5	50.6	33,066	838,920
1-4	0.0033	0.0129	96,194	1,245	381,787	67	9.6	36652	345135	15.1	51.6	10,617	3,257,091
5-9	0.001	0.0049	94,949	469	473,572	63.8	8.6	40727	432845	14.9	48.6	3,951	3,989,177
10-14	0.0009	0.0044	94,480	418	471,355	59.2	5.7	26867	444488	14.5	44.3	3,718	4,193,258
15-19	0.0012	0.0059	94,062	553	468,928	54.4	7.6	35639	433289	14.3	39.8	4,572	3,878,862
20-24	0.0012	0.0062	93,509	580	466,097	49.7	8.5	39618	426479	14.0	35.4	4,014	3,227,983
25-29	0.0014	0.007	92,930	650	463,022	45	10.6	49080	413942	13.7	31.0	3,766	2,681,008
30-34	0.0019	0.0094	92,279	868	459,227	40.3	12.2	56026	403201	13.2	26.7	4,670	2,472,089
35-39	0.0024	0.0121	91,412	1,104	454,298	35.7	14.3	64965	389333	12.7	22.6	5,275	2,170,157
40-44	0.0039	0.0193	90,307	1,740	447,187	31.1	17.9	80046	367141	12.2	18.5	7,820	2,009,883
45-49	0.0071	0.0349	88,568	3,088	435,117	26.6	23.5	102252	332865	11.5	14.8	11,906	1,677,626
50-54	0.0112	0.0546	85,479	4,666	415,733	22.5	30.9	128461	287272	10.7	11.4	13,478	1,200,975
55-59	0.0169	0.081	80,814	6,542	387,713	18.7	41.6	161289	226424	9.7	8.5	14,208	841,980
60-64	0.0267	0.1251	74,271	9,291	348,130	15.1	44	153177	194953	8.4	6.2	18,455	691,421
65-69	0.0424	0.1915	64,980	12,447	293,786	11.9	58.3	171277	122509	7.3	4.1	22,597	533,361
70-74	0.0679	0.2904	52,534	15,254	224,535	9.1	59.6	133823	90712	5.8	2.7	24,314	357,895
75-79	0.11	0.4314	37,280	16,082	146,196	6.8	73.2	107015	39181	4.5	1.4	23,247	211,335
80-84	0.1637	0.5809	21,198	12,314	75,206	5.1	81.5	61293	13913	2.9	0.7	16,006	97,750
All Ages												234,609	34,363,548

Table (6): Egypt health state life table, females, 2000

age	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	e_x	Disability prevalence	Years with disability	Years without disability	LED with disability	DFLE without disability	Actual Deaths	Actual Population
< 1	0.0008	0.0039	95,086	372	474,498	67.6	8.6	40807	433691	16.8	50.2	2,990	3,811,612
1-4	0.0007	0.0034	94,714	319	472,770	62.9	5.7	26948	445822	16.4	45.8	2,701	3,999,342
5-9	0.0008	0.004	94,394	382	471,017	58.1	7.6	35797	435220	16.2	41.3	2,968	3,661,891
10-14	0.0006	0.0039	95,086	372	474,498	67.6	7.4	35113	439385	16.8	50.2	2990	3811612
15-19	0.0007	0.0034	94,714	319	472,770	62.9	6.8	32148	440622	16.5	45.8	2701	3999342
20-24	0.0008	0.0042	94,012	399	469,066	53.3	8.5	39871	429195	15.9	36.8	2,574	3,029,867
25-29	0.0011	0.0055	93,614	512	466,791	48.5	10.6	49480	417311	15.5	32.4	2,747	2,505,554
30-34	0.0012	0.0061	93,102	571	464,085	43.8	12.2	56618	407467	15.1	28.1	2,864	2,329,254
35-39	0.0017	0.0084	92,532	780	460,709	39	14.3	65881	394828	14.6	23.8	3,500	2,067,910
40-44	0.0025	0.0124	91,752	1,140	455,910	34.3	17.9	81608	374302	14.0	19.7	4,926	1,970,233
45-49	0.0041	0.0202	90,612	1,832	448,481	29.7	23.5	105393	343088	13.2	15.9	6,940	1,699,120
50-54	0.0074	0.0364	88,780	3,236	435,812	25.3	30.9	134666	301146	12.3	12.3	9,332	1,256,816
55-59	0.012	0.0583	85,544	4,983	415,265	21.2	41.6	172750	242515	11.2	9.3	10,978	914,869
60-64	0.018	0.0861	80,561	6,938	385,461	17.3	44	169603	215858	9.8	6.8	14,128	784,874
65-69	0.029	0.1352	73,623	9,954	343,231	13.7	58.3	200104	143127	8.4	4.6	18,634	642,547
70-74	0.0479	0.214	63,669	13,626	284,283	10.5	59.6	169433	114850	6.5	3.0	22,109	461,274
75-79	0.0855	0.3521	50,044	17,622	206,164	7.6	73.2	150912	55252	4.9	1.5	24,121	282,199
80-84	0.1479	0.5398	32,422	17,500	118,360	5.4	81.5	96463	21897	3.0	0.7	20,150	136,282
All Ages												***205,516***	***33,520,928***

Table(7): Top 10 causes of loss of healthy life expectancy (in DALYs) worldwide, 2000

	GLOBAL	DALYs (000)	%
1	Acute lower respiratory infections	96 682	6.7
2	HIV/AIDS	89 819	6.2
3	Perinatal conditions	89 508	6.2
4	Diarrhoeal diseases	72 063	5.0
5	Unipolar major depression	59 030	4.1
6	Ischaemic heart disease	58 981	4.1
7	Cerebrovascular disease	49 856	3.5
8	Malaria	44 998	3.1
9	Road traffic accidents	39 573	2.8
10	COPDa	38 156	2.7
	All causes	1 438 154	100

Table(8): Top 10 causes of loss of healthy life expectancy (in DALYs) in EMRO B subregion (including Egypt), 2000.

Cause of Death	EMRO B	DALYs (000)	%
1	Ischaemic heart disease	1 484	7.1
2	Unipolar major depression	1 312	6.3
3	Perinatal conditions	1 134	5.4
4	Cerebrovascular disease	1 041	5.0
5	Diarrhoeal diseases	977	4.7
6	Acute lower respiratory infections	921	4.4
7	Road traffic accidents	881	4.2
8	Maternal conditions	704	3.4
9	Anaemias	607	2.9
10	Nutritional/endocrine disorders	492	2.4
	All causes	20 896	100

Table(9): Top 10 causes of loss of healthy life expectancy (in DALYs) in EMRO D subregion 2000.

Cause of Death	EMRO D	DALYs (000)	%
1	Perinatal conditions	10 621	10.4
2	Acute lower respiratory infections	9 625	9.5
3	Diarrhoeal diseases	9 146	9.0
4	Congenital abnormalities	5 446	5.4
5	Ischaemic heart disease	3 588	3.5
6	Unipolar major depression	3 227	3.2
7	Measles	3 020	3.0
8	Malaria	2 727	2.7
9	Road traffic accidents	2 298	2.3
10	Cerebrovascular disease	2 277	2.2
	EMRO D	101 688	%

Although the primary focus of the DALE analyses for the World Health Report 2000 has been on estimating severity-weighted disability prevalence and disability-adjusted life expectancy, we have also made an estimate of the global pattern of disability prevalence in terms of the seven disability severity classes used in the

Table (10): Disability Severity class weights Indicator conditions

1	0.00–0.02	Vitiligo on face, weight-for-height less than 2 standard deviations
2	0.02–0.12	Watery diarrhea, severe sore throat, severe anaemia
3	0.12–0.24	Radius fracture in a stiff cast, infertility, erectile dysfunction, rheumatoid arthritis, angina
4	0.24–0.36	Below-the-knee amputation, deafness
5	0.36–0.50	Rectovaginal fistula, mild mental retardation, Down syndrome
6	0.50–0.70	Unipolar major depression, blindness, paraplegia
7	0.70–1.00	Active psychosis, dementia, severe migraine, quadriplegia

Source: The Global Burden of Diseases, Vol 1 p40.

Note: These weights were established using the person trade-off method with an international group of health workers who met at WHO in Geneva in August 1995. Each condition is actually a detailed case. For example, angina in this exercise is defined as reproducible chest pain, when walking 50 meters or more, that the individual would rate as a 5 on a subjective pain scale from 0 to 10.