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The Global Burden of Disease

Review of the Art

By

Somaya Mahmoud El-Saadani

Assistant Professor
Department of Demography and Biostatistics
Institute of Statistical Studies and Research
Cairo University

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I. Introduction

As the human population of the world now witnesses a remarkable decline in mortality levels, populations experience a shift in the major causes of illness and death. Non-communicable and degenerative diseases are fast replacing the infectious diseases. Injuries (both unintentional and intentional) are also growing in importance (Salomon, et. al, 2002). By the year 2020, non-communicable diseases are expected to account for seven out of every ten deaths in the developing regions (Murray and Lopez, 1996). As the developed and developing world are facing a rapid aging of its populations and the number of adults relative to children increases, the population's commonest health problems become those of the adults and elderly. In all regions, the burden of diseases will pose serious challenges to health care systems and force decisions about the priorities and allocation of scarce resources. Taking account of these challenges, the World Bank in 1988 sponsored a four-year project on "Health sector priorities review" in which Christopher Murray introduced the Disability- Adjusted Life Years (DALY) as a common measure of cost-effectiveness of the health interventions. In 1992 the World Health Organization, the World Bank and the Harvard School of Public Health began a collaborative four-year project to provide a comprehensive set of estimates not only of the number of deaths by cause but also of total burden including burden from disability. This effort was commissioned as a background for the World Bank's Development Report (1993): Investing in Health. The World Bank's report made the case for the importance of health to both human and economic development, the need for more accurate epidemiological data on burden of disease by region, sex and age, and the need for measures of disease burden that combines mortality and morbidity. Following this work, the Global Burden of Disease (GBD) and Injuries study are published in a series of 10 volumes[1].

In the light that the statistics on health status of populations in almost all of the developing countries suffer from several serious limitations and shortcomings that reduce their practical value to policy makers, (they are partial and fragmented, unreliable, and for many cases the most basic data are not available), the Global Burden of Disease study included several processes: collecting and correcting all known data and information relating to disease and injury levels and patterns in all the WHO 191 Member States to produce age-sex-cause –specific epidemiological estimates for mortality and non-fatal health measures such as incidence, and prevalence, which are both internally consistent and preserve local variations and characteristics in epidemiological pattern, (Mathers et. al, 2001, pp.1-2). GBD set out three explicit objectives (Murrary, and Lopez, 1996, p.6):

1- To incorporate non-fatal conditions into assessments of health status, where health is more than the absence of death and disease,
2- To produce objective, independent and demographically plausible assessments of the burden of particular diseases away from advocacy, and
3- To have a single measure of disease burden to assess the cost-effectiveness of interventions in terms of cost per unit of disease burden averted. Moreover, to be

able to compare health conditions or health states between populations or overtime to quantify health inequalities.

Using the Disability – Adjusted Life Years (DALY), the Global Burden of Disease study achieved the following tasks, (Murray and Lopez,1996):

1) Developed "internally consistent estimates of mortality for 107 major causes of death by age and sex for world total and for eight regions of the world (China, Established Market Economies, Formal Soviet Union, India, Latin America and the Caribbean, Middle East Crescent, Pacific islands, Sub-Saharan Africa). 2) Developed estimates of the duration, the incidence, prevalence, and case-fatality rates for 483 disability sequelae caused by these 107 causes of disease and injury by age, sex and region, 3) Developed estimates of the fraction of mortality and disability attributable to 10 major risk factors by age, sex and region. The risk factors include: malnutrition; poor water supply, sanitation and personal hygiene; unsafe sex; tobacco use; alcohol use; occupation (health hazards through work); hypertension; physical inactivity; drug use; and air pollution, and 4) Developed projections of mortality and disability by cause, age, sex and region to the year 2020.

The review is organized into the following sections: Following the introduction, Global Burden of Disease approach to measure health status is reviewed in section two. In section three we present a summary of the key findings of the Global Burden of Disease. Section four presents a review of the critiques that have been addressed to the Global Burden of Disease study. Summery is presented in the last section.

II. Measuring the Global Burden of Disease

Over the last forty years, several summary measures of population and health were developed to quantify the burden of disease on the human population and define the world's main health challenges. The fundamental basis for these summary measures is to develop indicators of overall population health that incorporate simultaneously measures of premature mortality[2] and non-fatal health states. These summary measures are classified into two classes (both are complementary). The first class measures health expectancies. It estimates the average time (in years) that a person could expect to live in a good health with time spent in poor health is adjusted. Examples include disability-free life expectancy (DFLE) and disability-adjusted life expectancy (DALE). The other class measures health gaps. Health gaps measure the potential years of life lost due to premature mortality "mortality gaps" (difference between age at death and some ideal age at death) and time lived in states of ill-health, as examples, Potential Years of Life Lost (PYLL), Disability – Adjusted Life Years (DALY). Both classes of health measures use time (lived in a health states or lost through premature death) as a common metric for measuring the impact of mortality and ill-health outcomes. Disability–Adjusted Life Years as a measure of health gaps is adopted by the Global Burden of Disease Study. Health expectancy and health gap measures are demonstrated using Figure 1. In the

Figure, the bold line is the survivorship curve for a hypothetical population. The thin curve, area A represents time lived in good health, it is a hypothetical curve of survivors to each age x in full or optimal health. Area B is time lived in ill- health, and area C represents time lost due to premature mortality (a gap in years between age at death and some arbitrary standard, (60 or 80 years)). The total years lived is given by the area under the bold curve:

$$\text{Total years lived} = A + B \text{----------} (1),$$

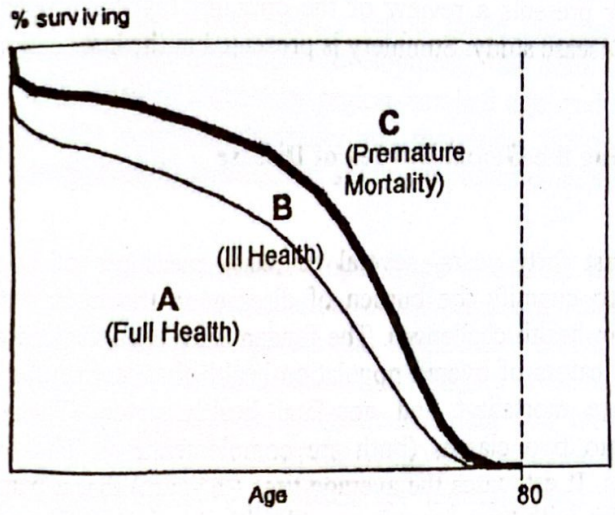
$$\text{Health expectancy} = A + f(B) \text{----------} (2)$$

Where, f( ) is some function that assigns weights to years lived in ill- health during time B. And,

$$\text{Health gap} = C + g(B) \text{----------} (3)$$

Where, g( ) is some function that assigns weights to health states lived during time B.

Figure 1. The survivorship curve.



Disability –Adjusted Life Years (DALY) from a disease or injury (as a health gap measure) are calculated as the sum of the years of life lost due to premature mortality (YLL) and the equivalent "healthy" years lost due to disability (YLD). One DALY is one lost year of 'healthy' life.

$$DALY_i = YLL_i + YLD_i \text{----------} (4)$$

Where, i stands for the health condition.

In measuring the gap between an individual's actual health status and some "ideal or perfect or reference" health state, GBD identified five "societal value choices" which are unavoidable (Mathers,, et. al, 2001; Murray and Lopez, 1996):

1- How long should people in good health expect to live?
2- Are years of healthy life worth more in young adulthood than in early or late life?
3- Is a year of healthy life gained now count more to the society than a year of healthy life gained sometimes in the future, for instance in 30 years' time?
4- Are all people equal? For example, should years of healthy life for an individual belonging to a certain socio-economic class count to the society more or should be weighted more than others'?
5- How should years of life lost through death be compared with years lived with poor health or disability of various levels of severity?

1- *How long should people in good health expect to live? Measuring years of life lost due to premature mortality (YLL)*

To measure the burden of the premature death or the gap between current mortality level at each age and some ideal age several approaches have been suggested and can be clustered into four families of measures, namely; potential years of life lost, period expected years of life lost, cohort expected years of life lost, and standard expected years of life lost. The four approaches differ only on how to measure the ideal age or the upper limit to life. Potential years of life lost (PYLL) is the simplest measure of time lost due to premature death, where a potential limit to life (or upper limit to life span of the individual) is chosen arbitrarily (for example, age 60). The years of life lost due to death at age x is the upper limit to life minus age at death,

$$PYLL = \sum_{x=0}^{L} d_x (L - x) \text{----------(5)}$$

Where, L is the arbitrary upper limit to life, x is the age at death and d_x is the number of deaths in the population at age x.

A wide range of the potential upper limits to life has been used ranging from 60-85 (Centre for Disease control, 1986). Others proposed that the limit to life should be set equal to life expectancy at birth for a given population (Dempsey, 1947, cited in Murray, 1996). The main advantages of PYLL as a measure of the burden of premature mortality rate are the ease of its calculation and the egalitarian treatment of all deaths at a given age. There are, however, two limitations. First, deaths beyond the selected upper limit do not contribute to burden. Second, if change in PYLL is used to assess the benefit of health intervention, any program which reduces mortality after the potential limit to life would have zero benefits. The other three suggested measures are based on the use of life expectancy calculations. In the period expected years of life lost (PEYLL), the duration of life lost is the community period life expectancy at each age.

$$PEYLL = \sum_{x=0}^{l} d_x e_x^0 \text{ ----------(6)}$$

where e^0_x is the period life expectancy at age x, l is the last age to which people survive and dx is the number of deaths at age x.

The advantage of this measure is that deaths at all ages contribute to the estimated burden of premature death. However, its main drawback is that the local life expectancies vary overtime and across communities. Hence its application would lead us to conclude that the death of a 40-year old woman in Cairo contributes less to the global burden of disease than the death of a 40-year old woman in Paris because the expectation of life at age 40 is lower in Egypt than in France. Due to the fact the mortality has been declining throughout the last decades so that the life expectancy of a birth cohort is much higher than the period life expectancy, others suggested using cohort life expectancies. Yet this approach has the same limitation that period expected life lost method suffers. The Global Burden of Disease study suggested using standard expected life expectancies. Accordingly, the standard expected years of life lost (YLL) due to premature death equals:

$$YLL = \sum_{x=0}^{l} d_x \, e^*_x \qquad (7)$$

Where $^*e_x$ is the expectation of life at each age x based on some standard life expectancy.

YLL has an advantage over the second and third measures, in that deaths at the same age in all communities contribute equally to the burden of disease. The standard life expectancies that were used are based on Coale and Demeny Model Life Tables, West, Level 26 which has a life expectancy at birth for females of 82.5 year. The choice of this model life table was based on the fact that the Japanese females have achieved a period life expectancy at birth higher than 82 years, a highest national life expectancy at that time.

The Global Burden of Disease study faced the following question: should the same standard expectation of life at each age be used for males as well as females? On the grounds of equity, a male death at age 40 should count as the same duration of life lost as a female death at the same age. However, the observed difference in survival potentials for females and males, even in rich low-mortality societies provides evidence for the existence of biological difference (Hahn and Eberhardt, 1995; Wikines et. al, 1989). Thus, a gender gap of 2.5 years is chosen as a reflection of biological difference in survival potential between males and females (Murray, 1996) and a standard life expectancy at birth for males of 80 years has been based on the female schedule for Coale and Demeny Model Life Tables, West, Level 25 as there is no male schedule with life expectancy of age 80[3].

2- Are years of healthy life worth more in young adulthood than in early or late life?

Age weighting function:

(Murray, 1996, p: 54) considered the following scenario:

"there is only one course of antibiotics available and two individuals with meningitis (التهاب سحائى) arrive simultaneously at the emergency room. The only difference between the two that you know about is their age: one is two years old and one is twenty-two. Their prognosis is identical, which patient would you choose to treat? Such a stark case forces consideration of a difficult choice."

Based on several studies and some population and health surveys, the GBD study concluded that individuals seems to assign greater value to preventing the death of young adults than of young children or older adults and assign non-uniform age weighting, (Bussbach et.al, 1993; Johanesson and Johansson, 1996, cited in Murray, 1996; Nord et.al, 1995). Three arguments were provided; a) individuals may value their own health at various age differently, b) individuals may attach greater importance to years of productive adult life, where young adults have already been educated and are about to contribute to overall production for the society, and c) young and middle-aged adults play critical role in providing care and well-fare to children and elderly. GBD used a continuous age weighting function of the form:

$$CX * e^{-\beta x} \text{ ----------(8)}$$

Where, β and C are constants take values 0.04 and 0.1658, respectively, (Murray, 1996,pp. 54-61).

3- Is a year of healthy life gained now count more to the society than a year of healthy life gained sometimes in the future, for instance in 30 years' time? Discounting future health:

Despite widespread use of discounting in the evaluation of health projects, discounting future health is widely debated and still is not easily resolved. Discounting life years is different from discounting future dollars. Hereby, The GBD study calculated DALYs with and without discounting. A 3.0% positive discount rate is arbitrary chosen to capture the uncertainty that increases with time. A continuous discounting form is used, e^{-rt}, where, r is the discounting rate and t is the time.

4- Are all people equal? For example, should years of healthy life for an individual belonging to a certain socio-economic class count to the society more or should be weighted more than others? Equity proposition

In quantifying ill-health and its severity, the Global Burden of Disease study faced the fact that illness of every individual is unique. It is affected by a host of factors; its pathology, severity, duration of disability, the characteristics of the individual (age, sex, educational attainment, income, occupation, ethnicity, etc.) and the social, economic and cultural setting in which he lives and its response to his illness. In the light of this complicated aspects of individual's ill-health, GBD study adopted two complementary propositions; "restricted information" and "treating like health outcomes as like". The

first states that "the non-health characteristics of the individual affected by a health outcome that should be considered in calculating the associated burden of disease should be restricted to age and sex". According to this proposition one should be completely indifferent to treating one over the other. The income of the patients or their social class in the society should have no bearing on who should receive the life saving intervention. The second proposition states that "the burden calculated for the like health outcomes should be the same". This means that the burden of any ill-health state, for example primary infertility among females of similar age, has the same weight regardless of the society in which she lives or her characteristics, etc.,(Murray, 1996, pp: 5-8).

5- How should years of life lost through death be compared with years lived with poor health or disability of various levels of severity? Measuring disability weights and equivalent "healthy" years lost due to disability (YLD)

In conceptualizing the various 'health-related quality of life' the International Classification of Impairment, Disabilities and Handicaps (ICIDH) (WHO, 1980) was adopted[4]. Disability not handicap has been chosen by the GBD study for evaluating the health–related quality of life. This is to ensure consistency with the principle of treating "like as like". Handicap focuses on the impact of disability given the particular social and cultural milieu in which individuals live. For example, impact of primary infertility on a woman's life living in a rural setting may differ from its impact on the live of a counterpart living in urban setting. Moreover, its impact differs among countries, developed countries compared to underdeveloped countries. Measuring disability weights is a two-step procedure. The first step is to make "objective" descriptions of the diseases and the second is to value one year of life lived with the described diseases relative to one year lived in perfect health. Seven domains of health in which disability is measured and weighted are identified, namely: mobility, self-care, participation in usual activities, pain and discomfort, anxiety and depression, cognition, and social participation. The severity weights take ranges between zero (full health) to one (equivalent to death). These weights provide the link between time lost due to premature mortality and ill-health conditions that allow the two to be combined in a summary measure[5]. The valuation process of the levels of severity or disability for any health state has been conducted in the GBD study by using Person Trade-Off (PTO) protocol[6]. It took two forms: PTO1 and PTO2. In the first, a respondent is trading quantity of life for healthy individuals and disabled individuals. For example, "suppose you are facing a choice between two programmes and only enough money to fund one of them. Would you prefer to save a healthy year of life for; 1000 healthy people or for 2000 blind people or for 8000 quadriplegics (شلل رباعى)?". In the second form, PTO2, a respondent is trading-off quantity of life for healthy individuals versus improved quality of life for a group of disabled individuals. The respondent is asked to choose between preventing deaths of X people in perfect health, or preventing the onset of some ill health state A in a different number of people Y. The value of Y at which respondent is indifferent between the two options gives an indication of the valuation of state A relative to perfect health and death. For example, "suppose you may be faced with a choice between extending the life of 1000 healthy individuals for one year or giving perfect vision back to 2000 blind individuals who will live for one year".

The GBD study faced the following question: Whose values are measured? there was an extensive debate on whose values and preferences should be measured; patients living in a health state, Patients' families, health-care providers or the general public. In theory, the first three groups have intimate knowledge of a health state with different degrees[7]. Health-care providers have been selected because of their knowledge of each of the conditions and its consequences. Eight expert groups of health-care providers have been selected from all over the world. The results of disability weights of an international meeting assembled at the World Health Organization in 1995 have been chosen for the fifth version of GBD Study.

Thus the equivalent "healthy" years lost due to disability (YLD) from a given health state or disability state equals:

YLD = I * DW * L ----------(9)

Where, I is the number of the incident cases in the reference period, DW is the disability weight and L is the average duration lived with disability (in years).

Estimating YLD needed a huge data set on disability incidence, disability duration, age of onset, and distribution by severity. These in turn required estimates of incidence, remission rates, case-fatality rates, all disaggregated by age and sex[8].

III. The Global Burden of Disease in 1990 (GBD 1990): key findings[9]

III.1 Deaths due to each cause in 1990

According to the Ninth Revision of International Classification Of Diseases (ICD-9) causes of death were grouped into three broad cause groups: Group I: Communicable, maternal, perinatal, and malnutrition conditions, Group II: Non-communicable conditions, and Group III: Injuries (unintentionally and intentionally). The three groups contain 107 individual causes of death at its 3rd level of disaggregation.

GBD results reveal that just over 50 million people died world wide in 1990 of whom 78.4% in developing countries. The results display that world wide, despite the epidemiological transition deaths from communicable diseases, maternal and perinatal conditions and malnutrition deficiencies (Group I) continue to take a heavy toll (although they are largely avoidable). One death in every three is from Group I causes. Virtually all of these deaths are in the developing regions. And just over half of the total deaths are from Group II causes. Far above the majority of these deaths are in the developed countries. One death in ten is from Group III causes. Developing regions stand in sharp contrast with the developed ones. In the former, four deaths in every 10 and close to half of the deaths are from Groups I and II. In the developed regions 86 per cent of the deaths is from Group II. Very trivial percentages (6.1% and 7.6%) of their deaths were caused by Groups I and III. GBD1990 results display that for several major developing regions, more people already die of Group II causes than Group I except India and Sub-Saharan Africa where do Group I causes still dominate, accounting for 51% and 65% deaths, respectively. These results clearly demonstrate that non-communicable diseases are not related to affluence any longer.

The ten leading causes of death include among them; ischaemic heart diseases (ذبحة صدرية), cerebrovascular diseases (جلطة دماغية), lower respiratory infections and diarrhoeal diseases are the top 4 causes in developing countries. Cerebrovascular diseases, ischaemic heart diseases, lung cancer, and lower respiratory infections are the top 4 causes in developed countries. Ischaemic heart diseases cause more deaths than any other disease or injury. Over the majority (57.1%) were in developing countries. Cerebrovascular diseases killed 4.4 million people of whom 78.2% in developing countries too. Nearly, all lower respiratory infections deaths are members of the developing countries (91.7%) and virtually all diarrhoeal diseases deaths are developing world cases. World wide, 5 million people died from injuries. Road traffic accidents represent the 8th and 10th leading cause of death in developed and developing regions, respectively. Two thirds of them are men, and most of these deaths are heavily concentrated among young adults. The significance of injuries has been largely overlooked by the health sector in many countries.

III.2 The Global Burden of Disease: Years of life lost due to premature death and disability (DALYs):

Results reveal severe regional imbalances in the burden of disease. In terms of DALYs, about 579 years of healthy life were lost for every 1000 people in Sub-Saharan Africa, compared with just 124 for every 1000 population in more developed regions and 300 years lost for every 1000 people in the Middle East Crescent. This assessment demonstrates clearly the glaring inequalities of world health at the end of the 20th century. The peoples of Sub-Saharan Africa and India together bore more than four-tenth of the total global burden of disease in 1990, although they make up only 26 per cent of the world's population. By contrast, countries of the developed regions with about a fifth of the world's population in them bore less than 12 per cent of the total disease burden. China emerged as substantially the most "healthy" of the developing regions, with 15 per cent global disease burden and a fifth of the world's population. The rate of premature deaths (YLLs) varied sharply between regions, with rates 7 times higher in Sub-Saharan Africa than in the developed countries. By contrast, the rates of disability were less varied, with Sub Saharan Africa having twice the rate of YLDs as the rich countries.

The leading causes of GBD in 1990: Group I causes "The traditional enemies" remains a significant force. In Sub Saharan Africa, two out of three years of healthy life lost (DALYs) were due to Group I conditions. Even in China, where the epidemiological transition is far advanced, a quarter of years of healthy life lost were due to this Group. World wide, five out of the ten leading causes of disease burden are Group I conditions. Injuries are a large and neglected health problem in all regions. In almost all regions, unintentional injuries were a much bigger source of ill-health than intentional injuries, such as interpersonal violence and war. The only exception was the Middle East Crescent, where unintentional and intentional injuries took an approximately equal toll because of a particularly high burden of war in the region. When causes of death are compared, in rank order, with causes of global disease burden, substantial differences

emerge, again reinforcing the need to take non-fatal conditions into account as well as deaths when assessing a population's health status. While a few leading conditions- such as lower respiratory infections, diarrhoeal diseases, perinatal conditions- are at the top of both lists, there are 14 conditions in the top half of the list of disease burden that are in the bottom half of the list of deaths. Depression is the most marked of these.

The toll of premature death (YLLs): according to YLLs, non-communicable diseases that affect mainly middle aged adults and older people account for only 31 per cent of YLLs compared with 56 per cent of deaths. Injuries account for 15 per cent of YLLs while it accounted for 10 per cent of deaths and communicable diseases account for 54 per cent of YLLs although it is responsible for 32 per cent of deaths.

The toll of disability (YLDs): Most significantly, the study shows that the burden of psychiatric conditions has been heavily underestimated and overlooked. Of the ten leading causes of disability world wide, measured in years lived with a disability, five were psychiatric conditions. Altogether, psychiatric and neurological conditions (Mental illness) accounted for 28 per cent of all YLDs. Compared with 1.4 per cent of all deaths and 1.1 per cent of years of life lost due to premature death (YLLs).

The predominance of these conditions is by no means restricted to the rich countries, although their burden is highest in these Established Marked Economies. They were the most important contributer to YLDs in all regions except Sub-Saharan Africa.

Alcohol use is the leading cause of male disability and the tenth largest in women in the developed regions. It also occupies the fourth largest cause in men in developing regions. The remaining important causes of YLDs were anemia, falls, road traffic accidents, chronic obstructive pulmonary disease (التهاب حاد فى الشعب الهوائية) and osteoarthritis (هشاشة العظام).

The new results suggest that older people in developed countries are healthier than their counterparts in developing countries. Most importantly, GBD results indicate that people in the high-income, low-mortality populations of developed regions not only live longer, but remain healthier for longer too. Ill health is 'compressed " into the last few years of life in these populations. Whiles still in the developing regions longer life merely exposes people to a longer period of poor health. These results also suggest that the proportion of the life span lived with a disability falls as life expectancy rises. A 60 year-old in Sub-Saharan Africa is expected to spend about half his or her remaining years with disability, whereas in individual living in developed countries of similar age is likely to spend just one-fifth of those years disabled.

Sex difference in Disease Burden: Although in infancy and early childhood, girls and boys suffer from broadly similar health problems, striking sex difference emerge in adults. First, and most obviously, women suffer from their reproductive role. In developing regions, five out of the ten leading causes of DALYs, are related to reproductive ill-health, including the consequences of unsafe abortion (almost all of this loss of healthy life is avoidable). Although the burden of reproductive ill-health is almost entirely confined to the developing regions, it is so great that even world wide, maternal conditions make up 3 out of the ten leading causes of disease burden in women aged

between 15-44. In both developed and developing regions, depression is women's leading cause of disease burden. Suicide is the forth in developing regions. Results emphasize that interventions to reduce the unacceptably high burden of poor reproductive health must remain a high priority for years to come. Moreover, women's psychological health deserves great attention and should be taken into account. For men aged 15-44, road traffic accidents are the biggest cause of ill-health and premature death world wide and the second biggest in developed regions, surpassed only by depression. Depression and road traffic accidents together with alcohol use, violence, tuberculosis, war make up top six causes of ill-health among males.

IV. Global Burden of Disease and injuries Study: a critical appraisal:

The Global Burden of Disease Study was heavily criticized for the societal value choices that have been adopted in measuring DALY. These criticisms are summarized as follows:

1- *Different standard life expectancy according to sex*: choosing greater life expectancy for females than males tend to disfavour males. Much of the difference between males and females is largely determined by male's higher exposure to life threatening behaviours (such as alcohol drinking, tobacco smoking, occupational hazards or injuries), (Anand and Hanson, 1998, 1997; Arnesen and Nord, 1999; Nygaard, 2000). Females too their lives are terribly threatened through their reproductive roles. In order to properly measure the biological difference the confounding effects of these health hazards should be eliminated.

2- *Discounting DALYs:* Several studies disagree discounting future health. As stated by Anand and Hanson (1998, p: 309), "We can see no justification for a measurement of the time lost due to illness or death which depends on when it occurs". If a person experiences an illness today and another person identical in all relevant respects, experiences an illness of exactly the same description next year. Discounting amounts to concluding that the quantity of the same illness is lower in the later case. Moreover, discounting DALYs at a rate 3% per annum implies that one life saved today will be worth more than 5 lives saved in 55 years, since $((1.03)^{55} = 5.08)$. More importantly, discounting future health gains is disadvantageous for children and future generations and for preventive medicine. It also justifies the many forms of environmental degradation today that benefit the present generation at the expense of future generations (Anand and Hanson, 1997; Arnesen and Nord, 1999; Nygaard, 2000).

3- *Age weighting*: the age weighting function disfavours children and old people. According to the used formula (see, equation (8)), a year lived at age two and a year lived at age 70 are valued at 20% and 46%, respectively, of a year lived at age 25 (the age at which the age weighting function is at its maximum). Furthermore, when the same illness for the same duration is experienced by persons of different age, it will produce (through age-weighting) different quantities of ill-health as measured by DALYs, lower for the

elderly and young and higher for the middle age-groups. Why a measure of illness should depend on the age of individuals? Using such age weighting is well matched the human capital approach in which time is valued in terms of the economic productivity of the individual. If the human capital approach justification for age-weighting is adopted, then it follows that an individual's life should also be valued according to his discounted lifetime earnings and his occupational skill, etc. GBD study explicitly rejects the human capital approach viewing instead age weighting as an attempt to capture different "social/familial roles" at different ages, for example ill-health of a middle-aged adult indirectly affects his dependents. This rationalization, however, would lead to the argument that the life-years, for example, of doctors and nurses should be valued much more highly than those in other profession because of their greater influence on individuals' health. In sum, age weighting and discounting measures the societal usefulness of people's life years rather than the individual's utility of life, (Anand and Hanson, 1998, 1997; Arnesen and Nord, 1999; Nygaard, 2000).

4- *Disability or handicap*: GBD study has chosen to measure disability rather than handicap because handicap varies with social situations. However, this ignores the fact that the impact of impairment on performance itself varies with social circumstances. According to the way in which disability classes are themselves defined, for example, Class 5, signifying quite severe disability, is defined as "needs assistance with instrumental activities of daily living such as meal preparation, shopping, and housework", the disables citizen of the North (with car, carry-out services at the supermarkets and freezer, etc..) might mange quite independently in a situation where the disabled citizen of the south, with identical physical impairment would be heavily dependent on his family. Thus, the proposed method for calculating DALYs inevitably reflects the impact of impairment in a particular social context. It is, in fact, not a context free measurement, (Barker and Green, 1996).

5- *Who should assign disability weights*?: This raises important questions: who should make such decisions and hence who is setting priorities? What constitute an "expert" in such valuation processes? The expert panels that have been chosen from health-care providers by the GBD study reflect the values of a skewed sample of the population. Further, working out disability weights is rather an academic task and will exclude illiterate and uneducated people.(Arnesen and Nord, 1999; Arnesen and Norheim, 1999; Barker and Green, 1996).

6- *Disability weights*: Several concerns raised from the use of disability weights: 1) Using one estimate of incidence and one disability weight, as was done in the GBD 1990 assumes a constant distribution of severity over time and between countries, (Mathers, et al, (2001). 2) The disability weights are not independent of the social context in which disability occurs. Thus, the DALY's disability classes enable the quantification of the amount of ill health, but do not provide adequate tools to evaluate the impact of the true "burden" of illness, (Anand and Nord, 1999). 3) Measurement of DALYs involves a systematic bias against individuals with permanent disability that have clear implications

for inequity. For example, a treatment that extends the life of a person in a wheelchair another year (without altering his disability) prevents fewer DALYs than the same treatment given to a perfectly healthy person. Thus, patient groups with the greatest potential improvements in health will therefore always be prioriterized while patients not having greater prospects of improvements will lose. Thus the existing inequality in health status between the able-bodied and the disabled will be exacerbated if DALY minimization criterion is used for resource allocation. 4) DALYs are not internationally comparable. If two or more countries could have the same burden of disease, one would not know if similar burden stemmed from equal numbers of ill people and the same disability assessments or from fewer ill people and greater disability weights or from more ill people and lesser disability weights. 5) Severity can have different expressions or appearances in different societies, countries, cultures and socio-economic classes. Thus, is it impossible, however, to formulate a definition that is suitable in all settings 6) In order to be able to calculate average severity, the severity levels must have scale properties. This means that the extent of increase in severity, when going from one level to the next, must be known, e.g. going from severity level 2 to level 3 must therefore represent the same increase in severity as going from level 4 to level 5. 7) Multi-pathology is not the same as multi-causality. Multiple risk factors are undoubtedly involved in the occurrence of various individual diseases, but the simultaneous coexistence of more than one disease in a given individual is by no means uncommon in developing countries. The hypothesis of a single disease makes DALY of questionable validity, (Arnesen and Nord, 1999; Arnesen and Norheim, 1999; Barker and Green, 1996; Nygaard, 2000; Sayers and Fliedner, 1997).

7- *Person Trade-Off (PTO)*: One assumption underlying the PTO method is that people are willing to trade years of life for quality of life. But for many people, saving lives will take precedence over improving health. In a systematic review of empirical studies using another method being tried by the GBD project, the Time Trade-off method, Arnesen and Norhiem (1999) found that up to 76 per cent of patients were unwilling to trade life time at all. Severely ill people were also reluctant to trade off lifetime. The same type of opinions were expressed at the January consultation meeting at WHO 2000 where some participants resisted weighting the saving of the lives of some against improving the health of others, (Nygaard, 2000). Arnesen and Nord (1999) reported similar findings from a meeting in the European GBD project. Sadana (1998) found poor women in Cambodia were refusing to use any valuation methods except the visual analogue scale. Many people feel uncomfortable balancing healthy years against death. The validity of valuing disability made in the face of serious doubts and outright resistance and refusal to participate are worth questioning. Moreover, the formulation of the PTO carries the implication that years of life of disabled persons have a lesser value than the years of life of healthy persons, (Arnesen and Nord, 1999). The proposition that the healthier the person, the more valuable their life is to themselves and to society and the greater their claim on restricted health care resources to have their life extended makes sense only if the value of life is seen as a dimension distinct from health.

8- *Single number*: One of the major difficulties with the DALY is that it obscures too much by pressing complex information (of both mortality and morbidity, disabilities, handicaps, culture, traditions, gender roles, health care organization and financing) into a

single numeric measure, (The DALY review group of the WHO Advisory Committee on Health Research (ACHR), 1996; Sayers and Fliender, 1997). Regional heterogeneity, for example, is more complex than GBD study implies. It is therefore pointless to press towards a single numerical measure, which in use, must be immediately disaggregated, (Barker and Green, 1996).

V. Summary

The review attempted to provide a summary of the large, ambitious, and objective project: The Global Burden of Disease; its underlying concepts, key findings and its main limitations.

To measure the Global Burden of Disease and Injury in the WHO 191 Member States, developed and developing, a comprehensive data set and estimates of 107 causes of death disaggregated by age and sex and region and epidemiological data set on 483 disease sequelae by age and sex and region were to collect, check and correct. No such huge data set was available in almost all the developing countries before GBD began. These considerable data requirements would enhance the health sectors to strengthen their registration systems, and their health information systems. Measuring the Burden of Disease locally and globally will open comprehensive and objective debates on the social values that influence priority settings and resource allocation in health. Moreover, it will enhance the identification of the major health problems and their relative magnitudes and the identification of health problems that may be neglected. Furthermore, it will point to the strengths and weaknesses of existing health information systems. The GBD findings demonstrate clearly that disability plays a central role in determining the overall health states of a population. The leading causes of disability are shown to be substantially different from the leading causes of death, thus casting serious doubt on the practice of judging a population's health from its mortality statistics alone.

Currently, WHO is undertaking a new estimation of the Global Burden of Disease for the year 2000 (GBD 2000), (Mathers, et. al, 2004). There are no major differences in the methodologies adopted in the two GBD projects. The main goals and specific objectives of GBD 2000 are similar to the original objectives of Global Burden of Disease for 1990 (GBD1990). The GBD 2000 draws on a wider range of data sources to develop internally consistent estimates of incidence health state, prevalence, severity, and duration and mortality for over 130 major causes (were 107 causes in GBD1990) and for over 500 sequelae resulting from the above causes (were 483 sequelae in GBD1990), disaggregated by age, sex, and 17 sub-regions of the world (were 8 regions in GBD 1990). The 5 age groups used in the GBD 1990 for each sex have been expanded to 8 age groups (0-4, 5-14, 15-29, 30-44, 45-59, 60-69, 70-79, 80+). The tree structure used for the classification of disease and injury causes is similar to that used for the GBD 1990 but includes some revisions and additional causes categories according to (ICD-10). Most importantly, GBD 2000 draws on the same value choices that have been adopted in GBD 1990. The GBD 2000 project, however, in an effort to improve the methodological and empirical basis for measuring disability weights, it moved from expert ratings alone to

involve 71 general population surveys combined with more detailed surveys among respondents with high level of educational attainment in the same sites (61 countries).

Recently, several countries have been conducting their National Burden of Disease (NBD) studies. They include among others, Algeria, Australia, Chile, Colombia, Ghana, Japan, Mexico, Morocco, Tunisia, Turkey, South Africa, Sweden and U.S.A.

Very recently, in Egypt, a M.Sc. Thesis has been issued by the Department of Statistics, Faculty of Economic and Political Science, Cairo University. Shawky (2004, pp: 42-51) proposed a modified formula for DALY to take account of the Patient's familial and economic roles. Specifically, the author suggests modifying the age weighting function to incorporate a dependency weighting function of two components: social dependency weights and economic dependency weights. She hypothesized a dependency weights range from 0 (total independent) to 1 (total dependent). These dependency weights were assigned to household members in the age groups: 0-20 and 60+. The dependency weight function declines with an accelerated rate in the age range 0-20 and increases with an accelerated rate for the age interval 60-80. Economic dependency weights are based on the years during which other household members are dependent on the patient's income multiplied by the relative share of the patient's income. The modified formula of DALY was applied using Saudi Arabia family Health Survey 1996 (SFHS-96) data set on two diseases; Diabetes and Asthma. Two conclusions of the study are worth mentioning. 1) The dependency weights significantly affected the DALYs for almost all the patients and changed their ranks. And 2) despite that the amounts of both DALYs and Modified DALYs (MDALYs) of diabetic patients were less than those of asthmatic's (the asthmatics are greater in number than diabetics), per cent change in DALYs due to including the suggested dependency weights was greater for diabetics than for asthmatics.

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[1] Volume I provides a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. Volume II provides Global Health Statistics: a compendium of incidence, prevalence, and mortality estimates for over 200 conditions. Volumes III-IX provide estimates of the global burden of groups of diseases; Health dimensions of sex and reproduction in volume III, The Global Epidemiology of Infections Disease in Volume IV, Global Perspective on Non-Communicable Disease in Volume V, Neuro-Psychiatric Disorders and Global Health in Volume VI, The Global Burden of Injuries in Volume VII, Malnutrition and the Burden of Disease in Volume VIII and Quantifying Global Health Risks: the burden of disease attributable to selected risk factors in Volume IX, and Volume X provides "Health Priorities and Burden of Disease Analysis: methods and applications from global, national and sub-national studies".

[2] A premature death is defined as one that occurs before the age to which the dying person could have expected to survive according to some ideal age or his life expectancy, or a standard life expectancy.

[3] The average sex difference in life expectancy at birth in more developed regions is 7.4 years (United Nations, 1995). The observed differences in survival for males and females, even in low-mortality societies, are complex function of biological differences, exposures, occupations, social roles, and command over resources. A number of authors have attempted to estimate the maximum life span for males and females.

Using a range of modelling methods, estimates of the difference between male and female maximum lifespan range from 1.9 to 3.2 years with females have the greater lifespan than males. These results are consistent with the observation that in rich low-mortality populations male life expectancy approximates female life expectancy more closely, (Murray, 1996, pp: 16-18) .

[4] According to ICIDH, impairment is any loss or abnormality of psychological, physiological or anatomical structure or function. A disability is defined as any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for human being. And a handicap is a disadvantage for a given individual resulting from an impairment or a disability that limits or prevents the fulfillment of a role that is normal (depending on age, sex, and social and cultural factors) for that individual (Goerdt, A. et. al. 1996).

[5] For example, if blindness has a disability weight of 0.50 of full health. Then the time lost due to blindness equals duration of years lived in blindness state multiplied by 0.50.

[6] There are other variants of the valuation techniques such as Rating Scale or Standard Gamble, or Time Trade-off, which have been applied in other studies for evaluating the disability, (Nord, 1992; Richardson, 1994).

[7] Patients have the most intimate knowledge of a health state and therefore are best able to make the most accurate assessment of the utility of living with the health condition. Patients' families have intimate knowledge without actually suffering it. Several studies and surveys have found that family members, health care providers, and the general public appear to rate health states as being worse than the patients rate them. It has been observed that their assessments of their own health state may change over time due to adaptation, coping and adjustment processes, (Addington-Hall, et.al, 2001; Sen, A., 2002).

[8] Incidence of the disease is defined as the rate at which people become newly affected by the disease under study. Remission is the rate at which people with disease stop being a case of disease. Case-fatality is the rate at which patients die from the disease under study.

[9] This section draws heavily on: Murray, C.J. and A.D. Lopez. (eds). 1996. The Global Burden of Disease: Summary, The Global Burden of Disease and Injury Series. Cambridge. Harvard University Press.