Research Highlight

Global Burden of Disease, Injury and Risk Factor Study 2010: Its Policy Implications for China

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Results of the Global Burden of Disease, Injury and Risk Factor Study 2010 (GBD 2010) were released on December 13, 2012 in London, a series of papers concerning the project have been published in the Lancet[1]. Research findings of the project have been reported in the United States, the United Kingdom, Indonesia, China[2] and Australia, and widely applied across the world. In addition, the GBD 2010 will see more countries report their project research findings and implement these findings in the near future. The GBD 2010 provides researchers, administrators and policymakers with new and critical sources for their research, teaching and policymaking.

Neither coherent set of values on the effects of diseases, injuries, and risk factors on the population health nor comparable figures on non-fatal health outcomes between different populations were available in the 1980s. To address the information gap, Dr. Christopher JL Murray has put forward the new concept of using disability-adjusted life years (DALYs) to measure the health loss of populations. In 1991, the World Bank and the World Health Organization (WHO) initiated the first GBD study, marking the first systematic scientific effort to quantify the comparative magnitude of health loss due to diseases, injuries and risk factors by age, sex, and geographies in specific time points. This was followed by GBD revision efforts in 1999, 2000, 2001, 2002, and 2004, respectively.

GBD 2010 funded by Bill & Melinda Gates Foundation (BMGF) was initiated in 2007, with the Institute for Health Metrics and Evaluation (IHME) of the University of Washington as the coordinating institute. The present study is to highlight the methodology, indicators and innovations of GBD 2010, and its policy implications for China.

Methodology Used by GBD 2010 DALYs are a single measurement to quantify years of life lost (YLLs) as a result of premature death and years lived with disability (YLDs) or with any short-term or long-term health loss[3]. Simply, *DALYs = YLLs + YLDs,* and one DALY is equal to one lost year of health life. Also, GBD 2010 attributed the burden of diseases to 67 risk factors by using the comparative risk assessment (CRA) approach.

Calculation of YLLs First, data from 187 countries and on causes of death available between 1980 and 2010 were collected, including vital registrations, mortality surveillance systems, censuses, surveys, hospital records, police records, verbal autopsies, and mortuaries. Data quality was checked for completeness, diagnostic accuracy, missing data, stochastic variations, and probable causes of death[4-5]. Second, garbage codes were dealt by using the evidence from medical literature, expert judgment, and statistical methods to reallocate a more probable cause of death for each of the garbage codes. Third, different modeling strategies were selected based on the data strength to determine the number of deaths from each cause. Finally, YLLs for a particular cause of each of the 235 fatal outcomes included in the GBD 2010 list of causes of death were calculated by multiplying deaths in each sex-age group by the reference standard life expectancy at that age. The formula for computing YLLs is as follows:

$$YLLs=N\times L$$

Where N is the number of deaths by age group and sex, L is the life expectancy for that sex-age group in a standard life table. To get the YLLs for a particular cause of death, sex-age-specific YLLs were added up to form subtotal YLLs for that outcome, and subtotal YLLs for all outcomes were further added together to produce total YLLs at a given year in the given region.

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Calculation of YLDs YLDs were used to quantify non-fatal health outcomes of 289 of the 291 diseases and injuries in the GBD 2010 cause list including at the global and regional level[5]. It was necessary to estimate the prevalence of each of 1 160 sequelae for 291 diseases and injuries by sex-age group, geographic area, and calendar year for calculation of YLDs. Disability weights (DWs) range from 0 to 1, which represents the severity of health loss, with 0 standing for complete health and 1 for death[6-7].

The following formula was used for computing YLDs by cause, sex, age, year, and country.

$$YLDs_{sequela}=Prevalence_{sequela}\times DW_{sequela}$$

The prevalence, incidence, remission, duration, and excess mortality were systematically analyzed. The data sources included publications, cancer registries, antenatal clinic data, hospital discharge data, outpatient data, surveys, household surveys, cohort studies, and hearing, vision, and lung-function test results from surveys, etc.

DALYs Attributable to Risk Factors GBD 2010 quantified deaths, YLLs, YLDs, and DALYs attributable to 67 independent risk factors and clusters of risk factors[8-9]. The comparative risk assessment method was applied in GBD 2000. The fraction of a disease or mortality attributable to a risk factor in a population is called population attributable fraction (PAF). It indicates the proportional reduction in a disease or mortality that would occur if exposure to the risk factor is reduced to the lowest level (theoretical-minimum-risk exposure distribution). The following formula was used to calculate the PAF that can be estimated by sex and age, respectively.

$$PAF = \frac{P(RR\text{-}1)}{P(RR\text{-}1)+1}$$

Where RR is a relative risk used to assess the association between a risk factor and the risk of developing a disease (mortality). Usually, it is derived from the meta analysis. P indicates the exposure rate, such as the smoking rate and the percentage of physical inactivity, in a given population by sex-age and calendar year.

Hypertension is a risk factor causally associated with stroke (ICD-9: 430-438), ischemic heart disease (ICD-9: 410-414), renal disease (ICD-9: 580-589), and other cardiovascular diseases. Meta analyses show that each RR of the above diseases is associated with hypertension. The population blood pressure distribution was determined by referring to literature or epidemiological surveys. So, PAF for each disease causally related to hypertension was estimated. The PAF of each disease was multiplied by the corresponding deaths or DALYs for that disease, which was used together with the sum of all deaths or DALYs for each of the diseases caused by hypertension to generate the total deaths and DALYs attributable to hypertension.

Innovations in GBD 2010 GBD 2010 systematically generated estimates for 291 diseases and injuries, 1 160 sequelae, and 67 risk factors by 21 regions across the world. However, GBD 2000 only saw inclusion of estimates for 107 diseases and injuries, 483 sequelae, 8 regions, 5 age groups and 10 risk factors, compared with estimates for twenty age groups and both sexes in GBD 2010.

Age weighting and discounting were taken into account in previous GBD studies; however, their uses have caused extensive debates in the past years. Age weighting assumes that the value of each year of life increases until 22 years old, and then the value decreases steadily. Discounting counted years of healthy life gained at the present is more valuable than years of life gained in the future. GBD 2010 no longer considered age weighting and discounting after consulting with a group of philosophers, ethicists, and economists.

To measure health loss from non-fatal outcomes, GBD 2010 required disability weights for 1 160 sequelae that capture the major health consequences of all the causes. Disability weights quantify the severity of outcomes as percentage reduction from complete health. The number of prevalent cases of each sequela multiplied by corresponding disability weight generates YLDs. Controversial issues have been raised in the past GBD studies, as the disability weights were developed based on expert judgments. Instead, the GBD 2010 study used household and internet surveys to determine the disability weights. Paired comparison was performed for data of web and household surveys to derive the disability weights.

The previous GBD results were presented in reports, publications, data sheets, or books; nevertheless, data visualization tools have been developed to present the results of GBD 2010 for free of use[10]. The GBD data visualization tools allow researchers, administrators, and policymakers to explore the health trends in different regions and countries and to view various estimates by combination of two or more indicators from the data warehouse.

The analysis of the burden of disease in GBD 2010 for China also has several limitations. First, the data are weak or absent for some disorders (e.g.,

autism, cannabis dependence, endometriosis, and genital prolapse), and there are substantial differences in data between the available data sources in other situations. For example, population-based cancer registry data and causes of death are inconsistent in some age groups for some cancers. Second, the 67 risk factors are proximal and behavioral risk factors, and social determinants are not analyzed due to lack of available data and sufficient evidence. Third, disability weights are crucial to calculate YLDs, but they were derived from data of other countries and thus may not be applicable to China. Finally, the GBD 2010 is a national analysis that may mask the substantial variations in some important outcomes because China is so large and diverse. Annual assessment of the burden of diseases, injuries, and risk factors should be undertaken at the national and provincial level.

Policy Implications for China Findings from GBD 2010 have offered new and critical evidence and can guide China's health policymaking. DALYs comprehensively assess the impact of 291 diseases and injuries, and 67 risk factors on the population health at two time points from both fatal and non-fatal outcome perspectives. On the one hand, DALYs, instead of indicators alone, provide a more accurate profile of the main risk factors for health loss. On the other hand, data on changing patterns for deaths, YLLs, YLDs, DALYs, and attributable risk factors are a useful tool for policymakers to understand health trends over time.

Summing premature mortality and disability in terms of DALYs provides a full picture of the health problems in China. The top 10 causes of DALYs in 2010 were stroke, ischemic heart disease, chronic obstructive pulmonary disease (COPD), low back pain, road injury, lung cancer, liver cancer, major depressive disorder, diabetes, and falls. Low back pain and major depressive disorder largely cause disability. The mean ranks of the 9 causes of death were higher in 2010 than in 1990 except for COPD. DALYs resulting from the above top 10 causes accounted for 37.67% of the total DALYs in 1990 and 43.18% in 2010, implying that non-communicable diseases contributed more to poor health in 2010 than in 1990. DALYs caused by diarrhea, lower respiratory infections, meningitis and other common infectious diseases had dropped by 77.0% and DALYs caused by tuberculosis by 71.5% since 1990. The life span of Chinese people has been prolonged; China has stepped into aging society and the mortality of children has declined. These changes have driven up premature death and disability (DALYs) due to non-communicable diseases in the last twenty years. Thus, the increasing burden of non-communicable diseases and injuries is becoming an urgent public health issue in China.

The mortality children under 5 years old in China was significantly lower in 2010 than in 1990 due to reduction of deaths from low respiratory infection (26 900 *vs.* 254 700), diarrheal diseases (1 900 *vs.* 47 400), tetanus (700 *vs.* 15 300), measles (300 *vs.* 20 000), tuberculosis (200 *vs.* 2 500), syphilis (1 700 *vs.* 12 200), and whooping cough (400 *vs.* 3 200). However, the number of HIV/AIDS deaths increased from less than 50 in 1990 to 400 in 2010 with a median percentage change of 4 232.1%. The number of deaths from communicable, maternal, neonatal, and nutritional disorders was lower in 2010 than in 1990, except for the deaths from HIV/AIDS, cysticercosis, iodine deficiency, acute hepatitis B, and acute hepatitis C, with the median percentage change increased by 9 447.6%, 3.8%, 12.8%, 7.0%, and 16.0%, respectively. The number of deaths due to HIV/AIDS, hepatitis B, tuberculosis, typhoid and paratyphoid fevers, meningitis, schistosomiasis, and diarrhoeal diseases was 36 200, 35 100, 44 700, 11 900, 7 700, 8 500, and 4 400 in 2010, respectively. The leading causes of death are shifting to non-communicable diseases. However, the control strategies for communicable diseases like tuberculosis and HIV/AIDS are still in force.

Health loss was mainly caused by stroke, which was followed by ischemic heart disease, COPD, road injury, lung cancer, liver cancer, stomach cancer, oesophageal cancer, and colorectal cancer, with a total of 797 800 deaths in 1990 and 993 100 deaths in 2010. A total of 260 200 lung cancer patients died in 1990 and 513 300 lung cancer patients died in 2010. Therefore, lung cancer and digestive cancer should draw the attention of researchers, health administrators, and policymakers, who should give priority to prevention, control and treatment of these cancers. Tobacco control, reduction of air pollution exposure, healthy diets, and improvement of drinking water quality are some of the effective measures to control such cancers.

Information on health loss due to avoidable risk factors can help policymakers prioritize preventive strategies for improving the population health. The most harmful risk factors include unhealthy diets (featuring being low in fruit, high in sodium, and low in whole grains), hypertension, tobacco smoking, ambient particulate matter pollution, household air

pollution, high fasting plasma glucose, alcohol use, exposure to occupational hazards, high body mass index, physical inactivity and low physical activity, high total cholesterol, and drug use. Public health interventions to reduce tobacco consumption, alcohol use, sodium intake, and to change dietary habits are effective strategies for control of ischemic heart disease, stroke, cancers and diabetes. Primary health care is also useful for implementation of interventions such as management and treatment of patients with elevated blood pressure, cholesterol and blood glucose, and overweight (obesity).

China is faced with challenges against air pollution. Ambient particulate matter pollution and household air pollution are the fourth and fifth leading risk factors for DALYs. The fraction of deaths or DALYs attributable to ambient particulate matter pollution will increase continuously due to its latent period, even though a series of regulations have been endorsed and implemented for the control of air pollution in Beijing and other cities.

The reduction in the age-specific mortality has prolonged the life span of Chinese individuals. However, chronic disability increases as a result of low back pain, major depressive disorder, neck pain, other musculoskeletal disorders, diabetes, osteoarthritis, falls, COPD, alcohol use, hearing loss, schizophrenia, anxiety, road injury, bipolar disorder, and dysthymia in terms of YLDs. The decrease of mortality in all age groups of people does not mean that people are healthier than before, as there are more disabled people in society. The health system should be aimed to prevent and manage chronic conditions cost-effectively to make people live longer with better health.

In summary, China has made considerable gains in health in the past 20 years, such as increased life expectancy, declined mortality of children, and reduced incidence of tuberculosis and respiratory infections. However, this is accompanied by the growing burden of non-communicable diseases and risk factors, such as irrational diets, hypertension, tobacco consumption, high fasting plasma glucose, alcohol use, high body mass index, physical inactivity, high total cholesterol levels, and drug use.

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