

Singapore's burden of disease and injury 2004

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ABSTRACT

Introduction: The Singapore Burden of Disease (SBoD) Study 2004 provides a comprehensive and detailed assessment of the size and distribution of health problems in Singapore. It is the first local study to use disability-adjusted life years (DALYs) to quantify the total disease burden.

Methods: The SBoD study applied the methods developed for the original Global Burden of Disease study to data specific to Singapore to compute the DALYs. DALY is a summary measure of population health that combines time lost due to premature mortality (years of life lost [YLL]) with time spent in ill-health (broadly-termed disability) arising from incident cases of disease or injury (years of life lost due to disability [YLD]). DALYs, stratified by gender and age group, were calculated for more than 130 specific health conditions for the Singapore resident population for the year 2004.

Results: In 2004, diabetes mellitus, ischaemic heart disease and stroke were the top three leading causes of premature death and ill-health in Singapore, and together accounted for more than one-quarter (28 percent) of the total disease burden (in DALYs). Morbidity burden (YLD) was responsible for 52 percent of the total DALYs, with diabetes mellitus, anxiety and depression, and Alzheimer's disease and other dementias being the main sources of the total YLDs. Ischaemic heart disease, stroke and lung cancer were the major contributors to the premature mortality burden (YLL).

Conclusion: This study provides an objective and systematic assessment of the fatal and nonfatal health conditions in Singapore to support priority setting in public health policies and research.

Keywords: burden of disease, morbidity, population health problems, premature mortality, public health

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INTRODUCTION

We present an overview of the first Singapore Burden of Disease (SBoD) study conducted by the Epidemiology & Disease Control Division, Ministry of Health. The study aimed to provide a comprehensive assessment of disease burden attributable to over 130 major diseases and injuries, and several well-recognised risk factors for the Singapore resident population (comprising Singapore citizens and permanent residents) for the year 2004. It used the summary health-outcome measure, disability-adjusted life year (DALY) to quantify disease burden. DALY combines mortality (premature death) and ill-health (broadly termed as disability) in a single measurement.

The DALY concept was first developed by Murray and Lopez in the authoritative Global Burden of Disease (GBD) study to assess the health effects of more than 100 diseases and injuries and ten selected risk factors for the world as a whole and for eight regions in 1990.⁽¹⁻³⁾ Between 1998 and 2004, the World Health Organization (WHO) undertook a new assessment of the GBD for 2000 to 2002, incorporating improved methods, and new and more extensive data.⁽⁴⁻⁷⁾ Summaries of consecutive revisions and updates were published yearly in the WHO's World Health Reports. In Fall 2007, an initiative to perform a thorough GBD reassessment for 1990 and 2005 (GBD 2005) was commenced by a consortium led by the Institute for Health Metrics and Evaluation, involving the WHO, University of Queensland and the Johns Hopkins and Harvard Universities, and supported by the Bill & Melinda Gates Foundation.⁽⁸⁾ This effort was estimated to take three years and will produce new estimates of the burden of disease for more than 150 diseases and injuries and more than 25 risk factors, for 20 regions of the world. The methods and findings from the original GBD have also spawned multiple national or sub-national burden of disease assessments and past and future trends of health burden analysis.⁽⁹⁻¹⁵⁾

The demand for burden of disease assessment globally and at the country level continues to be high as analyses are useful to help guide priority setting in public health policies, and in assessing the performance of health promotion and the healthcare system over time. This paper describes some key findings on burden of disease and injury from the SBoD study conducted between October 2005 and May 2007.

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METHODS

DALYs for a disease or health condition in a population are calculated as the sum of the years of life lost (YLL) due to premature mortality from that cause and the equivalent years of “healthy” life lost to disability (YLD) from incident cases of the disease or injury for a particular time period: $DALY = YLL + YLD$. A DALY represents the loss of one year of “healthy” life and it allows the burden of disease in a population to be measured as the gap between current health status and an ideal situation where everyone lives to old age, free of disease and disability.

The SBoD study broadly followed the methods used in the original GBD 1990 study for the calculation of DALYs, but varied partially in disease classification, social value choices as well as disease models and the type of data used in burden of disease analysis.

- **Disease classification:** We modified the expanded list of diseases and injuries considered in the GBD 2000 assessment to remove specific health conditions not relevant to Singapore (e.g. malaria, tropical-cluster diseases),⁽⁵⁾ and included additional causes of public health importance in Singapore where data was available (e.g. DALYs were estimated for a total of 30 single malignant neoplasms in the SBoD study. This was far more comprehensive and detailed as compared to just 16 cancer causes covered in the GBD 2000). Anxiety disorders (panic, agoraphobia, social phobia and generalised anxiety disorder) and unipolar depressive disorders (major depression and dysthymia) were analysed as a single disease condition termed anxiety and depression, following the approach used in the Australian Burden of Disease study 2003 (ABD 2003) to cater for overlap in morbidity.⁽¹⁵⁾ The SBoD list of causes was finally ordered using the Ninth Revision International Classification of Diseases (ICD-9) codes,⁽¹⁶⁾ and it comprised three broad disease groups, 21 categories of disease and injury and more than 130 specific health conditions (see Appendix 1 for the complete list of SBoD cause categories).
- **Social value choices:** The study used a combination of severity weights based largely on the weights used in the Netherlands study and the 1990 GBD study.^(2,3,17) For some health states, the Australian derived disability weights from the ABD 2003 were used. Non-uniform age weights as used in the GBD, which give less weight to years lived at very young and at older ages, were not applied here. All other social value choices were consistent with the 1990 GBD study: a standard life table known as Coale and Demeny West Level 26 (with a life expectancy at birth of 82.5 years in women and 80 years in men) was used in the calculation of YLL,⁽¹⁸⁾ a discount rate of 3% was

applied to YLL in the future, so as to estimate the net present value of YLL.

Estimates of the Singapore resident population (Singaporeans and permanent residents) by gender and age group as of June 2004 were obtained from the Singapore Department of Statistics. The law requires all deaths occurring in Singapore to be registered with the Registry of Births and Deaths (RBD). More than 99% of all deaths in Singapore are certified by medical doctors and coroners.⁽¹⁹⁾ The compulsory reporting of deaths coupled with a high proportion of death certification by trained medical personnel have allowed for a complete and reasonably high level of accuracy of the ascertainment of the cause of death in Singapore. The RBD compiles information on the causes of deaths using ICD-9 (from year 1979 to date). Data from the RBD was used for cause-specific death rates, by gender and age, required for YLL estimation in the SBoD study.

We redistributed proportionally, by age and gender, deaths coded as ill-defined diseases (ICD-9: 780-799) to specific causes other than injuries. Ill-defined injury deaths (ICD-9: E980-E989), ill-defined cancer deaths (ICD-9: 195,199) and deaths due to heart failure (ICD-9: 428) were attributed in proportion, varying by age and gender across all specific injuries, all malignant neoplasms of specified sites and all specific cardiovascular causes (except stroke), respectively. Other cardiovascular garbage codes were reassigned to ischaemic heart disease deaths by age and gender based on correction factors for “low ill-defined coding” countries, where doctors certified, on average, a small proportion of ill-defined cardiovascular deaths.⁽²⁰⁾ Deaths due to these ill-defined conditions and garbage codes accounted for about 3% of the total deaths in Singapore in 2004.

Estimating YLD was the most challenging component of the burden of disease analysis. The data required for estimating YLD include: incident cases of a particular condition in the year of interest, duration, age of onset and distribution by severity class, all of which to be segregated by age and gender. The complete set of disease worksheets used in the ABD 2003 for disease-specific estimation of YLD was made available by the School of Population Health, University of Queensland, which oversaw the ABD 2003 study, to the SBoD study team. This provided a useful introduction to the disease models and types of data used. The SBoD study team developed modifications of the disease models, based on the availability and nature of detailed local data, and in consultation with local disease experts.

A wide range of data sources including national disease registers and surveillance or notification systems, national health surveys, health services utilisation data, local and

Table I. Top ten causes of premature mortality burden (in YLL) in Singapore in 2004 by gender.

Rank	Overall (% of YLL) (n = 174,530)	Males (% of YLL) (n = 98,737)	Females (% of YLL) (n = 75,793)
1	Ischaemic heart disease (19.0)	Ischaemic heart disease (21.4)	Ischaemic heart disease (15.9)
2	Stroke (10.1)	Stroke (8.9)	Stroke (11.7)
3	Lung cancer (7.2)	Lung cancer (8.6)	Breast cancer (6.9)
4	Lower respiratory tract infections (5.3)	Self-inflicted injuries (5.0)	Lower respiratory tract infections (5.7)
5	Colon & rectum cancer (4.7)	Lower respiratory tract infections (5.0)	Lung cancer (5.5)
6	Self-inflicted injuries (4.6)	Colon & rectum cancer (4.4)	Colon & rectum cancer (5.0)
7	Diabetes mellitus (3.4)	Liver cancer (3.8)	Self-inflicted injuries (4.1)
8	Breast cancer (3.0)	Road traffic accidents (3.3)	Diabetes mellitus (4.1)
9	Liver cancer (2.9)	Chronic obstructive pulmonary disease (3.2)	Nephritis & nephrosis (3.0)
10	Road traffic accidents (2.4)	Diabetes mellitus (2.8)	Hypertensive heart disease (2.3)

YLL: years of life lost

Table II. Top ten causes of disability burden (in YLD) in Singapore in 2004 by gender.

Rank	Overall (% of YLD) (n = 188,701)	Males (% of YLD) (n = 88,453)	Females (% of YLD) (n = 100,248)
1	Diabetes mellitus (17.9)	Diabetes mellitus (19.0)	Diabetes mellitus (16.9)
2	Anxiety & depression (11.8)	Anxiety & depression (8.2)	Anxiety & depression (15.0)
3	Alzheimer's disease & other dementias (5.5)	Stroke (5.3)	Alzheimer's disease & other dementias (6.1)
4	Schizophrenia (5.0)	Adult-onset hearing loss (5.3)	Schizophrenia (4.9)
5	Osteoarthritis (4.9)	Osteoarthritis (5.2)	Osteoarthritis (4.6)
6	Adult-onset hearing loss (4.8)	Schizophrenia (5.1)	Adult-onset hearing loss (4.5)
7	Stroke (4.2)	Alzheimer's disease & other dementias (4.9)	Vision disorders* (4.4)
8	Vision disorders* (4.2)	Autism spectrum disorders (4.1)	Breast cancer (4.3)
9	Autism spectrum disorders (2.7)	Vision disorders* (3.9)	Stroke (3.2)
10	Breast cancer (2.3)	Ischaemic heart disease (2.5)	Rheumatoid arthritis (2.3)

YLD: years of life lost due to disability

* includes low vision or blindness due to glaucoma, cataract, macular degeneration and all other causes; but excludes diabetic retinopathy and sight loss due to congenital causes, other diseases or injuries.

international epidemiological studies as well as experts' opinions and estimates were used in the YLD estimation. In conditions where prevalence data was available but not incidence data, a special disease modelling tool, DisMod II, was used to estimate a set of incidence rates by age and gender that matched the observed prevalence, given estimates of remission rates and cause-specific mortality risks derived from population data or epidemiological studies.⁽²¹⁾ DisMod II has been used extensively to supplement missing data and force consistency on the data that was available by exploiting the causal relations between the various variables that describe the disease process. The software is owned by the WHO and can be freely downloaded from the WHO website.⁽²²⁾

RESULTS

In 2004, 174,530 years of life were lost due to premature deaths (YLL), with males accounting for 30% more of the burden than females. Three-quarters of the premature mortality burden was due to cardiovascular diseases (34%), cancers (32%) and injuries (9%). Ischaemic heart

disease and stroke were the first and second largest specific causes of YLLs, respectively, in both males and females, and together were responsible for more than one-quarter (29%) of the total YLLs. These were followed by lung cancer, self-inflicted injuries and lower respiratory tract infections in males; and breast cancer, lower respiratory tract infections and lung cancer in females (Table I).

Non-fatal health outcomes were responsible for another 188,701 years of "healthy" life lost as a result of disability (YLD). In contrast to the premature mortality burden, the overall YLD burden was higher in females than in males (13% more). Mental disorders, neurological and sense disorders and diabetes mellitus accounted for nearly 60% of the YLD burden. The most important specific cause of disability in both males and females was diabetes mellitus, followed by anxiety and depression, which accounted for 30% of the total YLDs together. Stroke, adult-onset hearing loss and osteoarthritis were the third, fourth and fifth causes, and osteoarthritis in females (Table II). The disability burden of anxiety and depression in females was about twice that in males. For

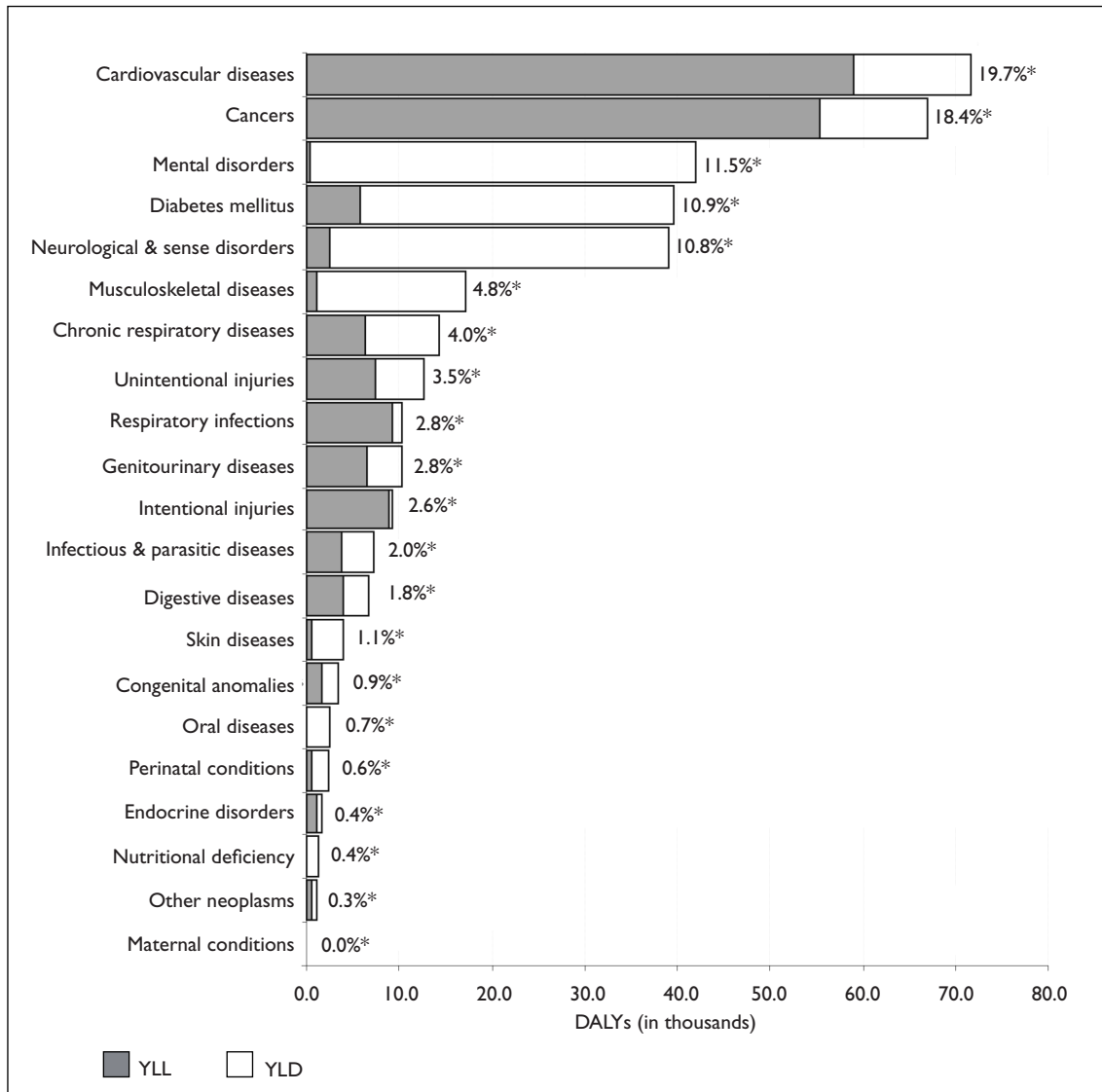


Fig. 1 Bar chart shows the burden of disease (years of life lost to premature mortality [YLL], years of life lost due to disability [YLD] and total disability-adjusted life years [DALYs]) for major disease categories in Singapore 2004.

* refers to the percentage of total DALYs for each disease category.

schizophrenia, which was the other mental disorder that caused significant disease burden, there was no apparent gender differential in the YLD burden.

The burden of disease and injury in the Singapore population for the year 2004 is shown in Fig. 1. Just over 360,000 years of “healthy” life (i.e. DALYs) were lost, which translates to 104 DALYs lost per one thousand residents, or in other words, an average probability of 0.104 of losing health due to illness or death in our population. Males accounted for 6% more of the burden than females. YLDs were responsible for 47% of the male burden and 57% of the female burden. Cardiovascular diseases (mainly ischaemic heart disease and stroke) and cancers (top specific cancers: lung, colon and rectum, and breast) were the leading causes of burden of disease and injury in Singapore, accounting for 38% of the total DALYs.

These were followed by mental disorders (anxiety and depression, schizophrenia and autism spectrum disorders), diabetes mellitus, and neurological and sense disorders (Alzheimer’s disease and other dementias, adult-onset hearing loss and vision disorders), which accounted for another 33% of total DALYs together. Diabetes mellitus carries a risk of ischaemic heart disease and stroke. The inclusion of the attributable burden of these cardiovascular diseases due to diabetes mellitus would increase the burden of diabetes mellitus from 11% to 15% of total DALYs, making it the third largest contributor to overall burden after cardiovascular diseases and cancers.

The burden due to specific disease conditions and injury reflected the more general picture at the broad disease category level. Fig. 2 shows the top 15 specific causes of disease and injury in 2004. These 15 leading

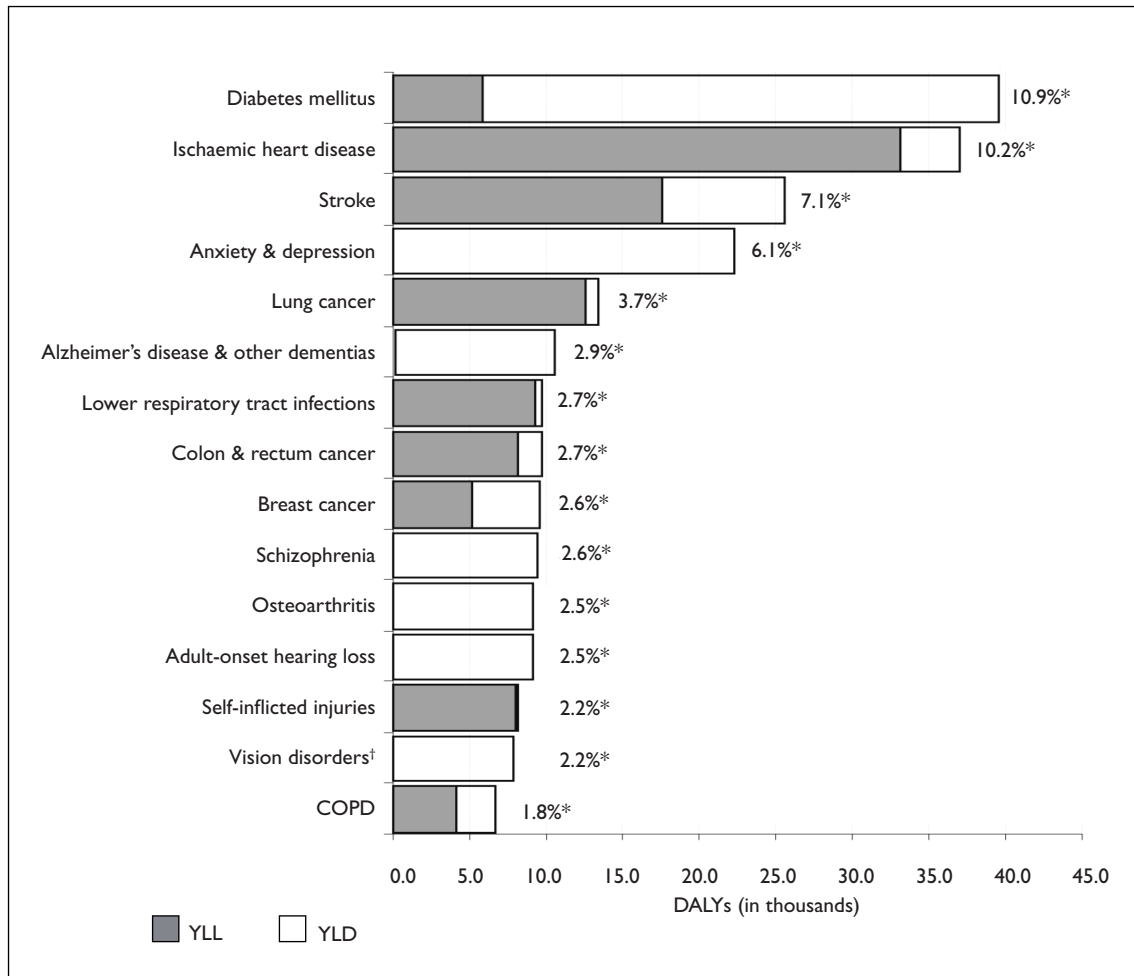


Fig. 2 Bar chart shows the 15 specific leading causes of disease burden in Singapore 2004.

COPD: chronic obstructive pulmonary disease.

† Includes low vision or blindness due to glaucoma, cataract, macular degeneration and all other causes; but excludes diabetic retinopathy and sight loss due to congenital causes, other diseases or injuries.

causes of disease burden in Singapore were responsible for more than three-fifths (63%) of the total DALYs, with diabetes mellitus, ischaemic heart disease and stroke alone causing 28% of the burden. Among these 15 main causes of the burden were six non-fatal or low fatality diseases, namely anxiety and depression, Alzheimer's disease and other dementias, schizophrenia, osteoarthritis, adult-onset hearing loss and vision disorders. The total burden per resident population increased exponentially with age, with an initial peak at birth (Fig. 3). Prenatal conditions and congenital anomalies were the common causes of DALYs in these babies. A smaller but similarly significant peak was also observed in early adulthood, dominated primarily by a burden due to mental disorders and injuries. Mental disorders were the most important cause group before the age of 40 years, while cancers, cardiovascular diseases and diabetes mellitus were prominent among middle-aged adults. Cardiovascular diseases overtook cancers as the major causal group of the total burden after age 65

years. The second and third largest source of DALYs in this elderly population were cancers and neurological and sense disorders.

Table III shows the specific causes of DALYs for the age groups: 0–14 years, 15–34 years, 35–64 years and ≥ 65 years. Autism spectrum disorders were the leading cause of disease burden in Singaporean children aged 0–14 years, accounting for one-fifth (21%) of their total DALYs. The respective second and third leading causes were asthma and attention-deficit hyperactivity disorder. Anxiety and depression exacted a substantial toll on the health status of our population aged 15–34 years. It was the most important cause of total disease burden in this age group (26%), followed by schizophrenia and diabetes mellitus. The burden due to road traffic accidents and self-inflicted injuries also ranked high for these young adults. Diabetes mellitus was the leading contributor of disease burden in adults aged 35–64 years (16%), followed by ischaemic heart disease and stroke. These conditions were

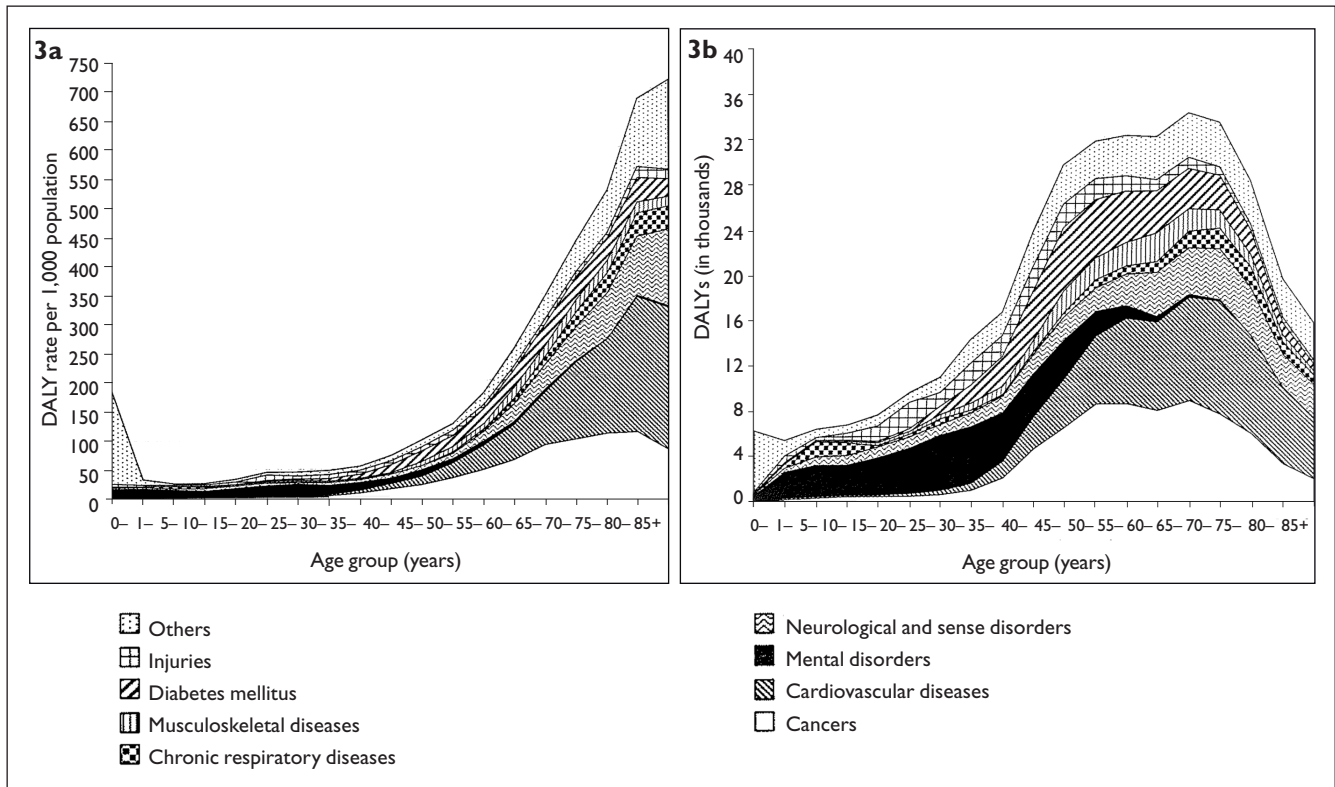


Fig. 3 Graphs show the DALY (a) rates and (b) numbers by age and major disease categories in Singapore 2004.

similarly featured among the top three causes for older Singaporeans (aged ≥ 65 years), but with ischaemic heart disease (16%) ranked first followed by stroke and diabetes mellitus. All cancers combined accounted for 23% and 20% of the total disease burden in adults age 35–64 years and ≥ 65 years, respectively, with burden due to breast and lung cancers being the most prominent in the former age group, and lung as well as colon and rectum cancers in the latter. Alzheimer's disease and other dementias were of particular concern for older Singaporeans.

DISCUSSION

The SBoD study is the first local study to provide a comprehensive and detailed assessment of the size and distribution of health problems in our population based on a critical review of the best available information on mortality and epidemiological parameters required for over 130 major causes of disease and injury. The inclusion of non-fatal health outcomes had provided a substantially different picture from that of traditional mortality-based assessments of population health.

Results from the SBoD study have validated the long-standing status of cardiovascular diseases (ischaemic heart disease, stroke), cancers and diabetes mellitus as the main disease control priorities in Singapore. National disease control strategies for these diseases have focused on promoting healthy lifestyles, the management of chronic diseases that are vascular risk factors (hypertension, diabetes mellitus and lipid disorders), and the early

detection of cancers. In 2001, the Singapore Health Promotion Board (HPB) was established to implement national health promotion and disease prevention programmes, such as the National Smoking Control Programme, which utilises a multi-pronged strategy, including fiscal measures, tobacco control legislation, public education, collaborative partnerships and provision of smoking cessation services; and the National Healthy Lifestyle Programme, which aims to create and foster a supportive environment for Singaporeans to practise healthy behaviour (the four components of health lifestyle being regular exercise, healthy eating, managing stress, no smoking). HPB also implemented the BreastScreen Singapore and CervicalScreen Singapore programmes, which encourage all Singapore women in the targeted age groups to go for regular screening mammography and Pap smears. More recently, Singapore implemented the Chronic Disease Management Programme nationwide in October 2006, starting with diabetes mellitus, and later extending to hypertension and lipid disorders.

The findings have also reinforced the increasing recognition of the importance of mental wellbeing in the population. The government has recently announced committing an additional S\$88 million in four key areas over five years (2007–2011) to build Singapore into a mentally resilient society.⁽²³⁾ These four areas are: increasing public awareness and education about mental wellbeing; piloting community-based mental health teams that will train community partners in schools, social

Table III. Top ten causes of disease burden (in DALYs) in Singapore in 2004 by age group.

Rank	0–14 years of age (% of DALY) (n = 24,668)	15–34 years of age (% of DALY) (n = 42,223)	35–64 years of age (% of DALY) (n = 165,873)	≥ 65 years of age (% of DALY) (n = 130,466)
1	Autism spectrum disorders (20.7)	Anxiety & depression (25.9)	Diabetes mellitus (15.6)	Ischaemic heart disease (16.1)
2	Asthma (10.9)	Schizophrenia (9.9)	Ischaemic heart disease (9.5)	Stroke (11.6)
3	Attention-deficit hyperactivity disorder (6.0)	Diabetes mellitus (6.5)	Stroke (6.1)	Diabetes mellitus (8.2)
4	Low birth weight (5.8)	Road traffic accidents (6.1)	Anxiety & depression (5.8)	Alzheimer's disease & other dementias (6.5)
5	Anxiety & depression (5.6)	Self-inflicted injuries (5.5)	Breast cancer (4.6)	Lung cancer (5.3)
6	Congenital heart disease (3.3)	Migraine (4.4)	Lung cancer (3.9)	Lower respiratory tract infections (4.8)
7	Falls (2.8)	Asthma (2.3)	Adult-onset hearing loss (3.7)	Vision disorders (4.2) [†]
8	Migraine (2.5)	Anorexia & bulimia (2.1)	Osteoarthritis (3.2)	Chronic obstructive pulmonary disease (3.7)
9	Other chromosomal disorders* (2.1)	Bipolar disorder (1.7)	Schizophrenia (3.0)	Colon & rectum cancer (3.7)
10	Lower respiratory tract infections (1.7)	Falls (1.5)	Self-inflicted injuries (2.9)	Osteoarthritis (2.8)

DALY: disability-adjusted life years

* excludes Down syndrome

[†] includes low vision or blindness due to glaucoma, cataract, macular degeneration and all other causes; but excludes diabetic retinopathy and sight loss due to congenital causes, other diseases or injuries.

agencies and general practitioners on ways to support the mental wellbeing of others and the early detection of mental health problems; strengthening mental health manpower; and mental health research. Another S\$17 million every year thereafter will be committed to promoting mental wellbeing.

Besides providing insight into the scope for future health gains in the population, detailed analysis of the study results could also possibly be used to support segmentation by age groups for prioritisation of resources and translation into strategies for action, such as in related manpower training and resource planning. For example, a steady growth in disease burden from the common chronic diseases due to ageing (the main contributors here were Alzheimer's disease and other dementias, hearing and vision disorders, and osteoarthritis) is to be expected as our population ages. It was projected by the Department of Statistics of the Singapore Government that one in five Singaporeans would be ≥ 65 years of age in 2030,⁽²⁴⁾ up from the current proportion of 8% in 2004.⁽²⁵⁾ A major consequence will therefore be an increased demand for relevant care services in the home, community and palliative care sectors. While burden of disease methodology can be used to inform health policy on prevention and treatment, we caution that it is not designed to inform policy on social support or welfare services for people with long-term disability. The term "disability" in DALYs is used in the widest sense to mean both short- and long-term activity limitations due to ill-health.

A limitation of this study is the availability of local epidemiological information for a number of important

conditions. This would impact on YLD burden estimation. Local incidence or prevalence data by gender and age were relatively complete for some diseases such as cancers and certain notifiable infectious diseases, but for a number of other key diseases, such as Alzheimer's disease and other dementias, osteoarthritis, adult-onset hearing loss and chronic obstructive pulmonary disease, the detailed information required was unavailable or generally limited. Information on the distribution of disease severity for conditions such as angina, heart failure, schizophrenia, adult-onset hearing loss, Alzheimer's disease and other dementias, asthma, vision disorders and chronic obstructive pulmonary disease were similarly scarce. Local population-based case fatality or relative risk knowledge for a vast majority of conditions were also inadequate and there was no information available for attributing conditions such as intellectual disability and cerebral palsy to underlying causes of disease and injury. In view of such data limitations, local experts in the respective diseases were consulted to scrutinise the set of epidemiological parameter estimates used in the development of the disease models, including the assumptions used (based on relevant international studies) to fill in data gaps, in order to ensure the plausibility of the results obtained.

These challenges of data availability are similar to those faced by disease burden studies all over the world, but the general philosophy is to pragmatically derive estimates based on the best available data, rather than wait indefinitely for ideal data. The data gaps uncovered help point the way toward potential future areas of epidemiological research in Singapore. Another issue relevant to the precision of our

estimates is the inability to adjust for comorbidities in the SBoD study to account for individuals who simultaneously experience multiple conditions.

The use of an assortment of Dutch and GBD sets of weights, and to a lesser extent, the Australians' derived weights, may not necessarily match Singaporeans' health state preferences and attitudes. However, an advantage of using internationally standardised disability weights is that it improves comparability across countries. It has also been found that the rank order of weights for most conditions has strong face validity and is reasonably constant for a set of "tracer conditions" when replicated in different countries.⁽¹⁵⁾ Future work to validate these disability weights used in the SBoD study or to derive a comprehensive set of weights, in the Singapore context, will be useful if feasible. Despite the limitations presented, we believe that the disease burden estimates from the SBoD study are likely to be more accurate than those estimated from the WHO GBD studies due primarily to the study team's access to better quality local data. Results from the study are also more up-to-date since the most recent set of WHO GBD DALY estimates for Singapore was based on data obtained in the year 2002 (and some of the data used may have been extrapolated from earlier years).

Nevertheless, as a form of validation of the calculated disease burden, we compared the DALY rankings by disease categories between the SBoD study and GBD 2002 estimates without age-weighting for Singapore, and found that the results were fairly consistent, with the top eight ranked major disease categories ascertained in the SBoD study in agreement with those of the GBD estimates for Singapore (data not shown). In Australia in 2003, cancers were ranked as the largest contributor of DALYs followed by cardiovascular diseases, mental disorders, neurological and sense disorders and chronic respiratory diseases.⁽¹⁵⁾ These were fairly similar to our findings (Fig. 1), with the exception of the diabetes mellitus burden, which was found to be higher in Singapore (11% of total DALYs) than in Australia (5% of total DALYs). The difference in the diabetes mellitus burden is not surprising, given the higher prevalence of diabetes mellitus in Singapore. Our findings, however, differed from those of a similar study conducted in Thailand in 1999, where the top ranked major disease category using DALYs was infectious diseases, followed by injuries (both intentional and unintentional), cancers, cardiovascular diseases and neurological and sense disorders.⁽¹¹⁾ This likely reflects differences in where the two countries lie along the epidemiological transition from low-income to high-income disease patterns. Singapore's disease burden profile is broadly consistent with that experienced in high-income countries, where a large proportion of the burden comes from chronic disease

conditions. Five of the top ten specific causes of DALYs in Singapore in 2004 (excluding anxiety and depression) were among the top ten causes of disease burden in the high-income countries. These include ischaemic heart disease, stroke, Alzheimer's disease and other dementias, lung cancer, and diabetes mellitus.⁽⁶⁾

Disease burden estimates reported here are developmental. Further improvements in methods and data to address the limitations discussed above are anticipated to increase the precision of these estimates for Singapore over time. DALYs as well as health-adjusted life expectancy (HALE), another summary measure of population health, derived from the SBoD study 2004, will be used as a baseline measurement for assessing improvements in the health and performance of Singapore's healthcare system over time. The results presented here together with subsequent work on risk factors burden and forecasts of future disease and injury burden in the population are also expected to assist in appropriate priorities setting for public health programmes, services and health research in Singapore. Findings on HALE, as well as the attributable burden due to key risk factors, will be reported in separate papers upon the completion of analysis.

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APPENDIX I. Singapore Burden of Disease Study 2004: disease and injuries categories.

<p>I. Communicable, maternal, perinatal & nutritional conditions</p> <p>A. Infectious & parasitic diseases</p> <ol style="list-style-type: none"> 1. Tuberculosis 2. Sexually transmitted diseases (excluding HIV/AIDS) <ol style="list-style-type: none"> a. Syphilis b. Chlamydia c. Gonorrhoea d. Other sexually-transmitted diseases 3. HIV/AIDS 4. Diarrhoeal diseases & gastroenteritis 5. Childhood-cluster diseases <ol style="list-style-type: none"> a. Diphtheria b. Whooping cough c. Tetanus d. Poliomyelitis e. Measles f. Rubella g. Haemophilus influenzae type b (Hib) 6. Meningitis (bacterial) 7. Septicaemia 8. Dengue 9. Hepatitis <ol style="list-style-type: none"> a. Hepatitis A b. Hepatitis B c. Hepatitis C 10. Malaria 11. Other infectious diseases <p>B. Respiratory infections</p> <ol style="list-style-type: none"> 1. Lower respiratory tract infections 2. Upper respiratory tract infections 3. Otitis media <p>C. Maternal conditions</p> <ol style="list-style-type: none"> 1. Maternal haemorrhage 2. Maternal sepsis 3. Hypertension in pregnancy 4. Obstructed labour 5. Abortion 6. Other maternal conditions <p>D. Perinatal conditions</p> <ol style="list-style-type: none"> 1. Birth trauma & asphyxia 2. Low birth weight 3. Neonatal infections 4. Other perinatal conditions <p>E. Nutritional deficiencies</p> <ol style="list-style-type: none"> 1. Iron deficiency anaemia <p>II. Noncommunicable diseases</p> <p>F. Malignant neoplasms</p> <ol style="list-style-type: none"> 1. Mouth & oropharynx cancer 2. Oesophagus cancer 3. Stomach cancer 4. Colon & rectum cancer 5. Liver cancer 6. Gall bladder cancer 7. Pancreas cancer 8. Lung cancer 9. Bone & connective tissue cancer 10. Melanoma 	<ol style="list-style-type: none"> 11. Non-melanoma skin cancer 12. Breast cancer 13. Cervix cancer 14. Uterus cancer 15. Ovary cancer 16. Prostate cancer 17. Testis cancer 18. Bladder cancer 19. Kidney cancer 20. Brain cancer 21. Thyroid cancer 22. Lymphoma <ol style="list-style-type: none"> a. Non-Hodgkin's lymphoma b. Hodgkin's disease 23. Multiple myeloma 24. Leukaemia <ol style="list-style-type: none"> a. Acute lymphoid leukaemia b. Chronic lymphoid leukaemia c. Acute myeloid leukaemia d. Chronic myeloid leukaemia e. Other leukaemia 25. Larynx cancer 26. Eye cancer 27. Other malignant neoplasms <p>G. Other neoplasms</p> <ol style="list-style-type: none"> 1. Uterine myomas 2. Benign brain tumours 3. Other benign neoplasms <p>H. Diabetes mellitus</p> <p>I. Endocrine disorders</p> <p>J. Mental disorders</p> <ol style="list-style-type: none"> 1. Alcohol use disorder 2. Schizophrenia 3. Anxiety & depression 4. Bipolar disorder 5. Anorexia & bulimia 6. Attention-deficit hyperactivity disorder 7. Autism spectrum disorders <p>K. Neurological & sense disorders</p> <ol style="list-style-type: none"> 1. Alzheimer's disease & other dementias 2. Epilepsy 3. Parkinson's disease 4. Multiple sclerosis 5. Migraine 6. Vision disorders <ol style="list-style-type: none"> a. Glaucoma related blindness b. Cataract related blindness c. AMD related blindness d. Other causes of blindness & low vision 7. Adult-onset hearing loss 8. Other neurological & sense disorders <p>L. Cardiovascular diseases</p> <ol style="list-style-type: none"> 1. Rheumatic fever & heart disease 2. Ischaemic heart disease 3. Stroke 4. Inflammatory heart disease 5. Hypertensive heart disease 6. Non-rheumatic valvular disease
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<p>7. Aortic aneurysm 8. Other cardiovascular diseases</p> <p>M. Chronic respiratory diseases</p> <p>1. Chronic obstructive pulmonary disease 2. Asthma 3. Other chronic respiratory diseases</p> <p>N. Digestive diseases</p> <p>1. Peptic ulcer disease 2. Cirrhosis 3. Appendicitis 4. Other digestive diseases</p> <p>O. Genitourinary diseases</p> <p>1. Nephritis & nephrosis 2. Benign prostatic hypertrophy 3. Other genitourinary diseases</p> <p>P. Skin diseases</p> <p>Q. Musculoskeletal diseases</p> <p>1. Rheumatoid arthritis 2. Osteoarthritis 3. Low back pain 4. Gout 5. Other musculoskeletal diseases</p> <p>R. Congenital abnormalities</p> <p>1. Anencephaly 2. Spina bifida 3. Congenital heart disease 4. Cleft lip and/or palate 5. Digestive congenital abnormalities a. Anorectal atresia b. Oesophageal atresia c. Other digestive congenital abnormalities 6. Urogenital tract malformations</p>	<p>a. Renal agenesis b. Other urogenital tract malformations</p> <p>7. Abdominal wall defect 8. Down syndrome 9. Other chromosomal disorders 10. Other congenital malformations</p> <p>S. Oral diseases</p> <p>1. Dental caries 2. Periodontal disease 3. Edentulism 4. Other oral diseases</p> <p>III. Injuries</p> <p>T. Unintentional injuries</p> <p>1. Road traffic accidents 2. Non-motor vehicle traffic accident 3. Poisoning 4. Falls 5. Fires/scalds 6. Drowning 7. Overexertion & strenuous movement 8. Natural & environmental factors 9. Machinery accidents 10. Suffocation & foreign bodies 11. Surgical/medical misadventure 12. Therapeutic drug reactions 13. Other unintentional injuries a. Cutting & piercing accidents b. Striking & crushing accidents c. Other remaining injuries</p> <p>U. Intentional injuries</p> <p>1. Self-inflicted injuries 2. Homicide & violence 3. Legal interventions & war</p>
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