



## Initial burden of disease estimates for South Africa, 2000

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**Background.** This paper describes the first national burden of disease study for South Africa. The main focus is the burden due to premature mortality, i.e. years of life lost (YLLs). In addition, estimates of the burden contributed by morbidity, i.e. the years lived with disability (YLDs), are obtained to calculate disability-adjusted life years (DALYs); and the impact of AIDS on premature mortality in the year 2010 is assessed.

**Method.** Owing to the rapid mortality transition and the lack of timely data, a modelling approach has been adopted. The total mortality for the year 2000 is estimated using a demographic and AIDS model. The non-AIDS cause-of-death profile is estimated using three sources of data: Statistics South Africa, the National Department of Home Affairs, and the National Injury Mortality Surveillance System. A ratio method is used to estimate the YLDs from the YLLestimates.

**Results.** The top single cause of mortality burden was HIV/AIDS followed by homicide, tuberculosis, road traffic accidents and diarrhoea. HIV/AIDS accounted for 38% of total YLLs, which is proportionately higher for females (47%)

than for males (33%). Pre-transitional diseases, usually associated with poverty and underdevelopment, accounted for 25%, non-communicable diseases 21% and injuries 16% of YLLs. The DALY estimates highlight the fact that mortality alone underestimates the burden of disease, especially with regard to unintentional injuries, respiratory disease, and nervous system, mental and sense organ disorders. The impact of HIV/AIDS is expected to more than double the burden of premature mortality by the year 2010.

**Conclusion.** This study has drawn together data from a range of sources to develop coherent estimates of premature mortality by cause. South Africa is experiencing a quadruple burden of disease comprising the pre-transitional diseases, the emerging chronic diseases, injuries, and HIV/AIDS. Unless interventions that reduce morbidity and delay morbidity become widely available, the burden due to HIV/AIDS can be expected to grow very rapidly in the next few years. An improved base of information is needed to assess the morbidity impact more accurately.

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Burden of disease information is an important component of health information required for health planning as it can be used to identify the health gaps in the population that need to be addressed to improve health status. Earlier analysis of South African mortality data has identified the unusual triple burden

of disease experienced in South Africa, arising from a combination of pre-transitional diseases and conditions related to poverty and under-development, emerging chronic diseases, and injuries.<sup>1</sup> More recently, it has been observed that this pattern is currently changing to a quadruple burden as a result of the HIV/AIDS epidemic.<sup>2,3</sup>

The global burden of disease (GBD) study,<sup>4,5</sup> published in 1996, made use of an innovative approach to rank the magnitude of different health problems using a single measure, the disability-adjusted life year (DALY). This combines the years of life lost (YLLs) from premature death and years of life lived with disabilities (YLDs). The use of YLLs emphasises the premature mortality from specific causes that can be targeted for prevention and the use of YLDs incorporates the burden arising from illness or injury. Another important aspect of the GBD study was to evaluate carefully the available data and to derive consistent and coherent estimates of mortality and morbidity for eight global regions, using a variety of demographic and epidemiological techniques.

South Africa is one of the few countries in sub-Saharan Africa that produces national cause of death statistics, but they are deficient, with significant underregistration and misclassification.<sup>1,6,7</sup> Furthermore, there are so few national morbidity data that it has been questioned whether the DALY

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can be estimated for South Africa.<sup>8</sup> Ironically, it is the lack of reliable, epidemiological data, compounded by the rapid changes in the health profile and the urgency of identifying suitable health interventions that make it essential to conduct a national burden of disease (NBD) study. Such a study attempts to identify the data deficiencies and provide the best possible estimates of the NBD to guide policymakers.

This paper outlines the first NBD study for South Africa,<sup>9</sup> which derives estimates for the overall levels and underlying causes of mortality and morbidity from various data sources. The main focus of this study was to identify the causes of premature mortality (YLLs) for the year 2000. In addition, estimates of the burden contributed by morbidity and injury are obtained to calculate the DALYs, and the impact of AIDS on premature mortality in the year 2010 is assessed.

## Methods

The 1990 GBD list of causes of death<sup>3</sup> has been adapted for this study, taking into account the disease profile in South Africa. The GBD classification system is important from a public health point of view, as it combines conditions of common aetiology or common interventions. It is divided into three broad groups: (i) group I, the pre-transitional causes, includes communicable diseases, maternal conditions, perinatal conditions, and nutritional deficiencies; (ii) group II includes the non-communicable causes; and (iii) group III, the injuries. HIV/AIDS is part of group I but is kept separate in this analysis due to the size of the burden that it contributes. Each group is divided into several major categories of causes of death, for example respiratory infections in group I, cardiovascular diseases in group II and intentional injuries in group III. These categories are further disaggregated into more specific causes of death. The full list is provided in the detailed report.<sup>9</sup> (It must be noted that the choice of aggregation of causes will affect the ultimate ranking.)

A modelling approach was necessitated by the lack of timely cause-of-death data and the profound health transition due to the rapid spread of the HIV/AIDS epidemic in South Africa. The number of deaths for the year 2000 is projected using the ASSA2000 model of the Actuarial Society of South Africa,<sup>10</sup> which has been calibrated to child mortality and adult mortality based on surveys, census and vital statistics as well as the antenatal HIV seroprevalence survey data.<sup>11</sup> The total number of deaths is estimated to be 556 585 and the infant mortality to be 59 per 1 000 live births, the under-5 mortality to be 95 per 1000 live births and the adult mortality based on the probability of dying between the ages of 15 and 60 years to be 49% for men and 36% for women.

The non-AIDS cause-of-death profile is estimated from three sources. First, the 1996 registered cause-of-death data are used to provide information on the cause-of-death profile for group I

and II diseases, excluding AIDS.<sup>12</sup> Ill-defined causes within a disease category have been reallocated proportionally by age and sex to the specified causes within that category. Experts were consulted in an attempt to refine this reallocation, particularly for cardiovascular diseases, perinatal conditions and congenital abnormalities. A multinomial regression model is used to reallocate the large ill-defined category into group I and II deaths on an age- and sex-specific basis, followed by a proportional allocation within the groups to specific causes.<sup>9</sup> Second, the cause-of-death information for 2000 processed by the Department of Home Affairs is used to estimate the overall proportion of deaths due to injuries by age and sex. Third, the University of South Africa/Medical Research Council (UNISA/MRC) national injury mortality surveillance system (NIMSS) for 1999 and 2000 is used to estimate the profile of fatal injuries.<sup>13,14</sup>

Premature mortality is estimated using the standard GBD approach to calculate YLLs.<sup>3</sup> This uses age weighting, discounting of 3% per year and standard life expectancies based on the West model levels, namely 25 for men and 26 for women.

Owing to the paucity of reliable morbidity information, the extent of burden from morbidity and non-fatal injury has been estimated based on the ratios of YLDs to YLLs estimated by the World Health Organisation (WHO) for the Afro E region.<sup>15</sup> This was done, for each of the disease categories for illustrative purposes.

The future impact of HIV/AIDS has been estimated for 2010 using the ASSA2000 model, assuming that the relative proportions of other causes remain the same as in 2000. Age-standardised YLL rates per 1 000 population are calculated using the WHO world standard population.

## Results

### Mortality

The cause-of-death and YLL profile by broad group is shown in Table I. Non-communicable diseases accounted for 37% of the deaths, followed by HIV/AIDS, which accounted for 30%. Females have a higher proportion of HIV/AIDS and non-communicable diseases and a lower proportion of injury deaths than males. There is a striking loss of years of life (YLLs) from HIV/AIDS (38%), which is proportionately higher for females (47%) than for males (33%). The group I causes account for 25% and group II causes account for 21% of the YLLs. Injuries account for 16% of the premature mortality: 8% for females and 22% for males.

The age distributions of the deaths for males and females are shown in Fig. 1. It can be seen that the age distribution of the deaths is significantly influenced by HIV/AIDS which contributes heavily to infant deaths and deaths at the young adult ages.



Table I. Estimated cause-of-death and YLL profile by sex, South Africa, 2000

	Deaths			YLLs		
	Male N = 303 081 (%)	Female N = 253 504 (%)	Persons N = 556 585 (%)	Male N = 6 529 811 (%)	Female N = 5 438 011 (%)	Persons N = 11 967 822 (%)
HIV/AIDS	26	34	30	33	47	38
Other group I	21	20	21	25	24	25
Group II	36	40	37	20	21	21
Group III	17	6	12	22	8	16
Total	100	100	100	100	100	100

Group I = communicable/maternal conditions/perinatal conditions/nutritional deficiencies; Group II = non-communicable diseases; Group III = injuries.

The mortality profile reflected in Fig. 2 shows the quadruple burden of disease experienced in South Africa. HIV/AIDS, chronic diseases, pre-transitional conditions and injuries all

contributed substantial numbers of deaths in 2000. After HIV/AIDS (30%), cardiovascular disease (16.6%), infectious and parasitic diseases (10.3%), malignant neoplasms (7.5%), intentional injuries (7.0%) and unintentional injuries (5.4%) are the leading cause-of-death categories. A higher proportion of deaths in women are due to HIV/AIDS and cardiovascular diseases than in males. Males have a higher proportion of injury deaths.

The top 20 causes of loss of life are shown in Table II. TB, diarrhoea, lower respiratory infections and low birth weight contribute to the pre-transitional conditions. Among the non-communicable diseases, stroke is the most important for females and ischaemic heart disease is the most important for males. Diabetes mellitus, hypertensive heart disease and cervical cancer feature in the major causes of YLLs for females, while chronic obstructive pulmonary disease, diabetes mellitus, cirrhosis of the liver and lung cancer feature for males. The burden from injuries, both intentional and unintentional, is much higher for males than females. The major specific causes

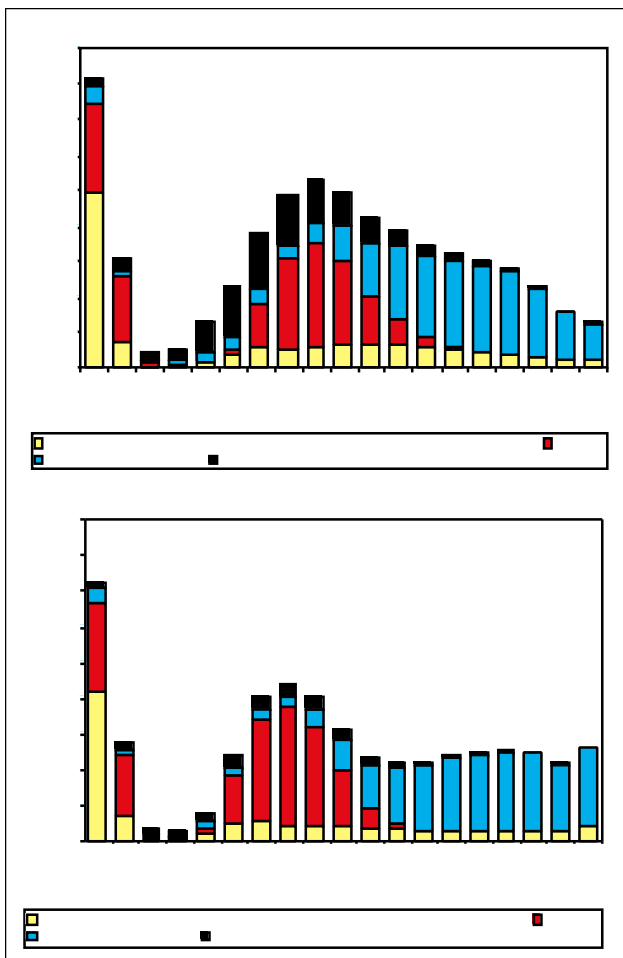


Fig. 1. Age distribution of deaths by group of causes and sex, 2000.

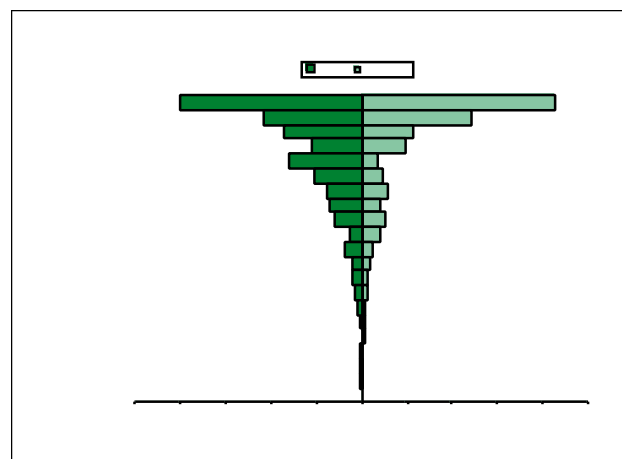


Fig. 2. Numbers of deaths for all ages by cause-of-death category, 2000.



Table II. Top 20 specific causes of the premature mortality burden (YLLs) by sex, South Africa, 2000

Rank	Males			Females			Persons				
	Cause of death (BOD list)	YLLs	%	Rank	Cause of death (BOD list)	YLLs	%	Rank	Cause of death (BOD list)	YLLs	%
1	HIV/AIDS	2 148 080	32.9	1	HIV/AIDS	2 517 330	46.3	1	HIV/AIDS	4 665 410	39.0
2	Homicide/violence	756 483	11.6	2	Diarrhoeal diseases	216 488	4.0	2	Homicide/violence	902 592	7.5
3	Tuberculosis	380 789	5.8	3	Tuberculosis	214 488	3.9	3	Tuberculosis	595 277	5.0
4	Road traffic accidents	344 868	5.3	4	Lower respiratory infections	209 240	3.8	4	Road traffic accidents	489 979	4.1
5	Lower respiratory infections	239 770	3.7	5	Low birth weight	180 274	3.3	5	Diarrhoeal diseases	452 827	3.8
6	Diarrhoeal diseases	236 339	3.6	6	Stroke	170 097	3.1	6	Lower respiratory infections	449 010	3.8
7	Low birth weight	213 489	3.3	7	Homicide/violence	146 109	2.7	7	Low birth weight	393 763	3.3
8	Ischaemic heart disease	175 906	2.7	8	Road traffic accidents	145 111	2.7	8	Stroke	318 083	2.7
9	Stroke	147 986	2.3	9	Ischaemic heart disease	108 531	2.0	9	Ischaemic heart disease	284 438	2.4
10	Suicide	123 822	1.9	10	Diabetes mellitus	86 154	1.6	10	Protein-energy malnutrition	171 433	1.4
11	Protein-energy malnutrition	93 556	1.4	11	Hypertensive heart disease	79 112	1.5	11	Suicide	163 544	1.4
12	COPD	74 459	1.1	12	Hypertensive heart disease	77 877	1.4	12	Diabetes mellitus	145 421	1.2
13	Fires	70 535	1.1	13	Protein-energy malnutrition	55 808	1.0	13	Hypertensive heart disease	127 066	1.1
14	Septicaemia	59 439	0.9	14	Fires	52 866	1.0	14	Fires	123 400	1.0
15	Diabetes mellitus	59 267	0.9	15	Cervix cancer	50 027	0.9	15	Septicaemia	115 247	1.0
16	Cirrhosis of liver	57 408	0.9	16	Neonatal infections	43 937	0.8	16	COPD	113 499	0.9
17	Trachea/bronchi/lung cancer	54 934	0.8	17	Asthma	43 037	0.8	17	Neonatal infections	96 819	0.8
18	Bacterial meningitis	54 876	0.8	18	Nephritis/nephrosis	43 025	0.8	18	Asthma	94 069	0.8
19	Neonatal infections	52 882	0.8	19	Suicide	39 721	0.7	19	Nephritis/nephrosis	93 973	0.8
20	Asthma	51 032	0.8	20	COPD	39 041	0.7	20	Bacterial meningitis	90 964	0.8
	All causes	6 529 811			All causes	5 438 011			All causes	11 967 822	

BOD = burden of disease; COPD = chronic obstruction pulmonary disease.

of YLLs are homicide, road traffic accidents and fires. In addition, suicides contribute to a large loss for males.

**Disability-adjusted life years (DALYs)**

The estimated DALYs for the disease categories are shown in Fig. 3, based on the YLD/YLL ratio estimated for the Afro E region by the WHO.<sup>15</sup> Preliminary attempts to calculate YLDs from local data suggest that this approach underestimates the YLDs. While these estimates cannot be considered accurate for South Africa, they do serve to highlight the fact that the mortality burden misrepresents the total disease burden in some cases. In particular, the contribution of nervous system disorders, respiratory disease, sense organ and mental disorders are significantly underrepresented based on mortality alone. In terms of DALYs, HIV/AIDS is the major contributor. This is followed by infectious and parasitic diseases, then unintentional and intentional injuries and perinatal conditions. It should be noted that suicides, which could represent the mortality component of mental health, are classified under intentional injuries and not under mental health.

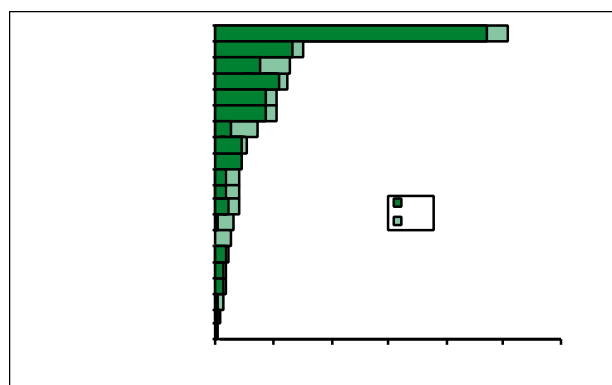


Fig. 3. Estimated DALYs by disease category in 2000.

**Projected impact of AIDS in 2010**

Since few data exist on how the HIV epidemic affects other causes of death, a fairly simple approach has been used to project its future impact. This approach takes the demographic impact of AIDS deaths into account and assumes that the profile of other causes of death remains the same and that there is no treatment intervention for HIV/AIDS. In such a scenario, the impact of HIV/AIDS will more than double the total burden of premature mortality by the year 2010, on an age-standardised basis (Fig. 4). While the premature mortality burden (YLLs per 1 000) was higher for males than females in 2000, it will rise more for females and by 2010 the YLL rates should reach similar levels. These results illustrate that HIV/AIDS is unlikely to diminish the burden from other causes significantly but rather adds substantially to them.



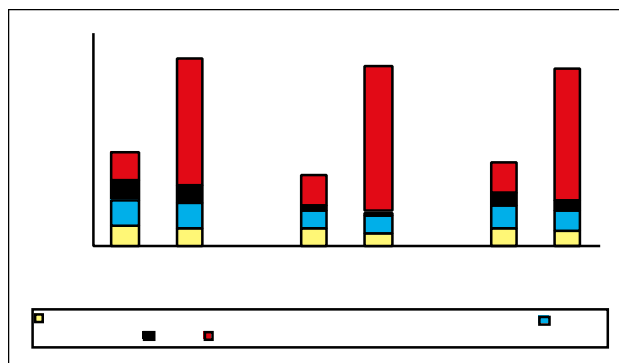


Fig. 4. Age-standardised YLLs per 1 000 by disease group for 2000 and 2010.

## Comparison of South African estimates with GBD 2000 regional estimates

Fig. 5 shows the proportion of total DALYs for each major cause group and HIV/AIDS for the six world regions defined by the WHO<sup>15</sup> compared with the initial burden of disease estimates for South Africa (South African NBD).<sup>9</sup> The quadruple burden facing South Africa is clearly demonstrated. Comparison of the DALY rates per 100 000 shows that South Africa has the second highest rates for all causes and group I conditions. The highest rates are for the African region. In addition, South Africa has injury rates that are higher than any region in the world, due mainly to the very high rates of intentional injuries. The DALY rate for HIV/AIDS is on a par with the African region. Also of note, is that the DALY rate for diabetes mellitus ranks second in the world after the American region.

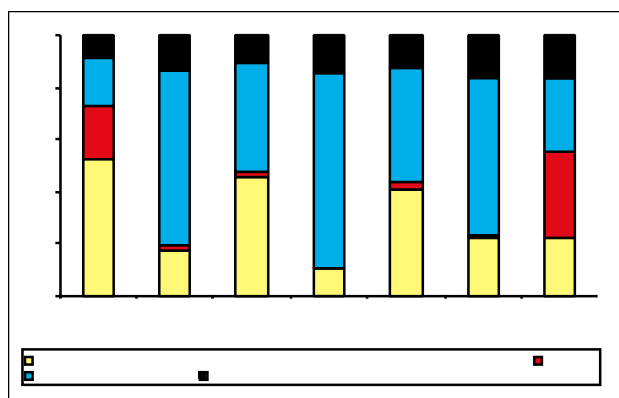


Fig. 5. DALY estimates by major cause group for South Africa and WHO world regions.<sup>15</sup>

## Discussion

The major limitation of this study is the lack of recent, complete and reliable mortality data, indicating the true

underlying cause of death, which necessitates the use of modelling to estimate the burden of disease. Subsequent to this study, Statistics South Africa released the results of the causes of death from a sample of the registered deaths for the years 1997 - 2001<sup>8</sup> which demonstrates the rapidly changing profile of mortality. Our estimate of 30% of the deaths due to HIV/AIDS is substantially higher than the proportion observed in their sample, which strictly reflects the cause of death as indicated on the death certificate. However, this can be explained by misclassification of HIV-related deaths as indicator conditions or co-morbidity (such as pneumonia and TB), as well as the large proportion of ill-defined conditions.

This study highlights that, other things being equal, the already large disease burden due to HIV/AIDS can be expected to grow rapidly in the next few years unless interventions that delay mortality and morbidity become widely available. A longer term consequence of the AIDS epidemic is the growing number of orphans. It is likely that their welfare will suffer, unless efforts are made to ensure that the basic needs of these children and psychosocial support are provided.<sup>16</sup> National government expenditure on HIV/AIDS for 2001/02 was R236 million, just 3.5% of the total national health budget.<sup>17</sup> This has been stepped up with the specific allocation for HIV/AIDS in the 2002/03 budget to just over R1 billion and almost double this amount for the year 2003/04.<sup>18</sup> However, this needs further attention considering that the almost 40% of premature mortality due to HIV/AIDS in 2000 can be expected to increase to 75% by 2010.<sup>11</sup> Recent research, which models the demographic and epidemiological impact of HIV/AIDS treatment and prevention programmes, suggests that the implementation of such programmes can significantly reduce the levels of new HIV infection.<sup>19</sup> However, prevention programmes alone will not impact significantly on mortality, morbidity or orphanhood in the short to medium term.

For the other causes of death, we have assumed that the profile of unregistered deaths follows the same pattern as that of the registered deaths and consequently could slightly over-represent an urban profile, which may be problematic as underregistration occurs largely in rural settings. This is compounded by our extrapolation of the injury profile from a surveillance system that has an urban bias. It was reassuring to find that the emerging rural demographic surveillance systems at Agincourt and Hlabisa show similar injury cause profiles to this study (Dr Kathleen Kahn and Dr Anna Maria Vanneste — personal communication). Even allowing for a margin of error, when compared with WHO estimates for the six global regions, it is clear that the injury burden experienced in South Africa is exceedingly high. Health promotion initiatives to reduce violence and injuries need urgent attention.

The standard GBD age weighting, discounting values and disability weights were applied in this study, which provides a basis for international comparison. Black and McLarty<sup>20</sup> suggest



that the value judgements incorporated in the DALY may not be valid in all settings and should be tested. On the basis of a low observed correlation between the ranking of severity of disabilities by Zimbabwean non-professionals and the GBD ranking, it has been suggested that countries should examine the preferences of their own citizens with regard to disability weights, before the GBD disability weights are used as a basis for resource allocation.<sup>21</sup> However, these may be lesser concerns than the uncertainty about cause-of-death distribution arising from the high proportion of ill-defined causes of death (15%) in 1996. It would have been ideal to conduct verbal autopsies on a representative sample of deaths in the ill-defined group. The estimates of YLDs and DALYs for South Africa should not be considered definitive, rather they should be viewed as initial estimates that could be revised if more information were available. Nonetheless they do illustrate the importance of including non-fatal outcomes when ranking diseases and conditions. Mortality alone clearly underestimates the burden of some conditions such as mental and nervous system ill health and sense organ loss. The study highlights the need for a more detailed assessment of non-fatal outcomes. The limited scope of this study particularly understates the likely burden due to depression. However, South Africa has large gaps in the database required to estimate national DALYs precisely, including consensus values for health states.

## Conclusions and recommendations

This study has succeeded in drawing together data from a range of sources to develop coherent estimates of the pattern of underlying causes of death in South Africa, providing useful information that can be used for national health planning. The study shows the unique quadruple burden of disease experienced in South Africa in the year 2000 — a combination of the pre-transitional diseases and conditions related to poverty, the emerging chronic diseases, injuries, and HIV/AIDS. There are certain to be marked differences in the mortality and morbidity profile between the various socio-economic and population groups and the provinces, which need to be investigated. It is essential to collect population-based data on mental health in South Africa.

The World Health Report for 2002<sup>22</sup> presents the findings from a global review of risk factors and identified 10 risk factors that account for more than one-third of all deaths worldwide: unsafe sex; alcohol consumption; tobacco consumption; obesity; hypertension; undernutrition; unsafe water, sanitation and hygiene; iron deficiency; indoor smoke from solid fuels; and high cholesterol. Considering the quadruple burden experienced in South Africa, it is likely that these risk factors contribute significantly to the ill health in the country. It would be useful to quantify the burden attributable to these risk factors in South Africa.

It is clear that further research is required to improve the burden of disease estimates and to estimate the cost effectiveness of many interventions. However, it is clear that the following interventions are likely to reduce premature mortality significantly in South Africa:

1. Reduce HIV transmission and delay mortality from AIDS in adults by improving treatment of sexually transmitted infections, improving voluntary counselling and testing services, providing antiretroviral treatment to pregnant HIV-positive women and HIV-positive patients, and promoting safe sex.
2. Improve TB control.
3. Develop strategies to reduce violence and injuries.
4. Promote healthy lifestyles (including a prudent diet, physical activity and reduced smoking, alcohol, and substance abuse).

The comprehensive health promotion approach used in Australia's state of Victoria and the achievements in reducing the spread of HIV/AIDS in Uganda need to be examined and emulated. However, we need to recognise that many of these health problems are socially and culturally rooted. Poverty, gender inequalities, crime and violence play a major role in exacerbating the health problems of the South African population. Efforts to improve health will have to extend to the very core of our society and cultures, with refurbishment of our social fabric and comprehensive strategies to reduce poverty.

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## References

1. Bradshaw D, Sitas F, Dorrington R. The level of mortality in South Africa 1985 — what does it tell us about health? *S Afr Med J* 1992; **82**: 237-240.
2. Bradshaw D, Schneider M, Dorrington R, Bourne D, Laubscher R. South African cause of death profile in transition — 1996 and future trends. *S Afr Med J* 2002; **92**: 618-623.
3. Statistics South Africa. *Causes of Death in South Africa, 1997 - 2001: Advanced Release of Recorded Causes of Death (P0309.2)*. Pretoria: Statistics South Africa, 2002.
4. Murray CJ, Lopez AD. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries and Risk Factors in 1990 and Projected to 2020*. Vol 1. Global Burden of Disease and Injury Series. Boston: Harvard School of Public Health, 1996a.
5. Murray CJ, Lopez AD. *Global Health Statistics*. Vol 2. Global Burden of Disease and Injury Series. Boston: Harvard School of Public Health, 1996b.
6. Botha JL, Bradshaw D. African vital statistics — a black hole? *S Afr Med J* 1985; **67**: 977-981.
7. Bradshaw D, Botha JL, Joubert G, Pretorius JPG, Van Wyk R, Yach D. *Review of South African Mortality (1984)*. Medical Research Council Technical Report No. 1. Cape Town: MRC, 1987.
8. Bradshaw D. Is the DALY measurable in South Africa? *S Afr Med J* 1996; **86**: 1483.
9. Bradshaw D, Groenewald P, Laubscher R, et al. *Initial Burden of Disease Estimates for South Africa, 2000*. Medical Research Council Technical Report. Cape Town: MRC, 2003. Available at: <http://www.mrc.ac.za/bod/bod.htm>. Accessed March 2003.



10. Actuarial Society of South Africa AIDS Sub-committee. *ASSA2000 AIDS and Demographic Model*. Available at <http://www.assa.org.za/information/AIDS/AIDSmodel>. Accessed June 2002.
11. Dorrington RE, Bradshaw D, Budlender D. *Provincial Profile of the AIDS Epidemic, Indicators 2002*. Cape Town: Actuarial Society of South Africa, Burden of Disease Research Unit and Centre for Actuarial Research, 2002.
12. Statistics South Africa. *Recorded Deaths, 1996*. Report No. 03-09-10. Pretoria: Statistics South Africa, 2000.
13. Burrows S, Bowman B, Matzopoulos R, Van Niekerk A, eds. *A Profile of Fatal Injuries in South Africa 2000: Second Annual Report of the National Injury Mortality Surveillance System (NIMSS) 2000*. MRC/UNISACrime, Violence and Injury Lead Programme Technical Report. Cape Town: MRC, 2001.
14. Buchart A, ed. *A Profile of Fatal Injuries in South Africa 1999: First Annual Report of the National Injury Mortality Surveillance System*. MRC/UNISACrime, Violence and Injury Lead Programme Technical Report. Cape Town: MRC, 2000.
15. World Health Organisation. *GBD 2000 Results (version 1). National Burden of Disease Studies: A Practical Guide (on CD-ROM)*. Global Programme on Evidence for Health Policy. Geneva: World Health Organisation, 2001. Available at <http://www.who.int/evidence/ibd>. Accessed April 2003.
16. Johnson L, Dorrington RE. *The Impact of AIDS on Orphanhood in South Africa: A Quantitative Analysis*. Centre for Actuarial Research Monograph No.4. Cape Town: University of Cape Town, 2001. Available at <http://www.commerce.uct.ac.za/care/>. Accessed April 2003.
17. Streak J. Mitigating the impact with a focus on government responses. In: Gov J, Desmond C, eds. *Impacts and Interventions: The HIV/AIDS Epidemic and the Children of South Africa*. Pietermaritzburg: University of Natal Press and UNICEF, 2002.
18. Hickey A, Ndlovu N. *What Does the 2003/4 Budget Allocate to HIV/AIDS?* Budget Brief No 127. Research Unit on AIDS and Public Finance, IDASABudget Information Service. Cape Town: IDASA, 2003. Available at: <http://www.idasa.org.ac>. Accessed April 2003.
19. Johnson LF, Dorrington RE. *The Demographic and Epidemiological Impact of HIV/AIDS Treatment and Prevention Programmes: An Evaluation Based on the ASSA2000 model*. Paper presented at the DEMSAconference, September 2002.
20. Black J, McLarty D. The DALY: boon or burden? (For Debate). *S Afr Med J* 1996; **86**: 1479-1481.
21. Jelsma J, Chivaura V, Mhundwa K, De Weerd W, De Cock P. The global burden of disease disability weights — whose values do they represent? *Lancet* 2000; **355**: 2079-2080.
22. World Health Organisation. *World Health Report 2002*. Geneva: WHO, 2002.

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