SA NBD 2 and SA CRA 2:

Disability Adjusted Life Years (DALYS)

Ian Neethling, Victoria Pillay-van Wyk, Jané Joubert,

Debbie Bradshaw & the SA NBD and SA CRA methods group.

Burden of Disease Research Unit

May 2017

Suggested citation:

Neethling I, Pillay-van Wyk V, Joubert J, Bradshaw D & the SA NBD and SA CRA methods group. SA NBD 2 and SA CRA 2: Disability Adjusted Life Years (DALYS); 2017. ISBN: 978-1-928340-27-0

Contact details:

Ian Neethling

Senior Scientist

Burden of Disease Research Unit

Medical Research Council

Tel: 021 938 0957

e-mail: ian.neethling@mrc.ac.za

Table of Contents

List of Figures

List of Tables

1. Introduction

The 2nd South African National Burden of Disease (2nd SANBD) and Comparative Risk Assessment Study (2nd SACRA) will make use of a disability adjusted life years (DALY) measure to assess the burden of disease for South Africa. The DALY is desirable for health decision making since it quantifies the extent of mortality, morbidity and disability in a single unit making it an ideal measure to assess diseases of priority, guide resource allocation and monitor the impact of health programmes. A DALY calculation consists of various parameters which requires different value choices. This document lays out the various parameters of a DALY and the value choices that were made for each parameter for the 2nd SANBD and 2nd SACRA studies.

1.1 Disability adjusted life years (DALY)

The DALY is a summary measure of population health which combines mortality and morbidity estimates into a single unit using time as the common metric (Murray and Frenk, 2002). It measures the gap between actual population health and a specified norm or goal. For the health gap, mortality is quantified by the future stream of life lost due to premature mortality measured as years of life lost (YLL) against a standard life expectancy, combined with the loss of healthy life due to disabling consequences of disease and injury measured as years lived with disability (YLD) (Murray and Frenk, 2002).

The computation of a DALY for any given condition is the sum of YLLs and YLDs for the condition as in equation (1)

$$DALY = YLL + YLD \quad (1)$$

where YLL is the years of life lost and YLD is the years lived with disability

Schroeder (2012) has classified DALYs as prevalence, incidence and hybrid. The different DALY classifications will be discussed in more detail later in the document. However, whichever DALY is used, a number of value choices need to be made for calculations.

To quantify years of life lost due to premature mortality a standard reference life expectancy (LE) is required for death at specific age groups (equation 2a). The YLL measures future stream of life lost and can be discounted to give a net present value while age-weighting could be applied to the YLL to give greater value to young or middle aged adults (equation 2b).

$$YLL_{cas} = N_{cas} \times LE_{as} \quad (2a)$$

where N is the number of deaths at a given cause (c) at specific age (a) and sex (s) and LE is the life expectancy at specific age (a) and sex (s)

$$YLL = N\,Ce^{(ra)} / (\beta+r)^2\,[e^{-(\beta+r)(L+a)}\,[-(\beta+r)(LE_{as}+a)-1] - e^{-(\beta+r)a}\,[-(\beta+r)a-1]] \quad (2b)$$

where r is the discounting rate at specific age (a), β is an age-weighting function parameter, C is the age weighting correction constant and LE is the life expectancy at specific age (a) and sex (s)

To quantify the YLD component of the DALY a choice needs to be made on whether the YLD will be incidence (Equation 3a) or prevalence (Equation 3b) based. An incidence DALY requires the duration and severity of the disability, whereas only the severity of the disability is required for a prevalence YLD. A set of disability weights is required to quantify the loss of health associated with different health states.

$$YLD_{cas} = I_{cas} \times DW_{cas} \times L_{cas} \quad (3a)$$

$$YLD_{cas} = P_{cas} \times DW_{cas} \quad (3b)$$

where I is the number of incident cases for a defined period, for a given cause (c) at a specific age (a) and sex (s), DW is the disability weight a given cause (c) at a specific age (a) and sex (s), L is the duration of the condition (c) at a specific age (a) and sex (s), and P is the number of prevalent cases for a defined period for a given cause (c) at a specific age (a) and sex (s)

Considering the options for the DALY to be used in the 2nd SANBD and 2nd SACRA studies, Table 1 lists the five value choices that need to be made and the decisions required for each value choice in a DALY calculation. The remainder of the document scopes the different value choice parameters and the proposal made on each parameter for the 2nd SANBD and 2nd SACRA studies.

Table 1. DALY value choices and options

Value choice	Options
Standard life expectancy	GBD 2010 standard life table, WHO standard life table or West model level 26 (used in GBD1990, 1st SANBD)
Discounting	Discounting rate of 3%, no discounting or other discounting rate
Age weighting	Age weighting or no age-weighting
Prevalence/Incidence or Hybrid	Which type of DALY and how will it be estimated?

Disability weight	GBD 2010 disability weights, GBD 2013 disability weights, WHO 2012 disability weights or local disability weights

1.2 Comparability of estimates from the 2nd SANBD and GBD 2010 studies

The global burden of disease has generated estimates of YLLs, YLDs and DALYs in their three most recent updates of 2010, 2013 and 2015. To assess the validity of their estimates for South Africa we decided to compare the YLLs of the 2nd SANBD study to that of the GBD 2010 study.

YLLs generated from the 2nd SANBD study with 3% discounting rate and the West level 26 standard LE were compared with YLLs generated using the IHME GBD 2010 standard LE and no discounting. The YLLs for the 2nd SANBD study follows a similar trend, but is lower than that of the IHME GBD 2010 study across all years (Figure 2), which is expected given the lower LE and discounting rate applied in the 2nd SANBD study.

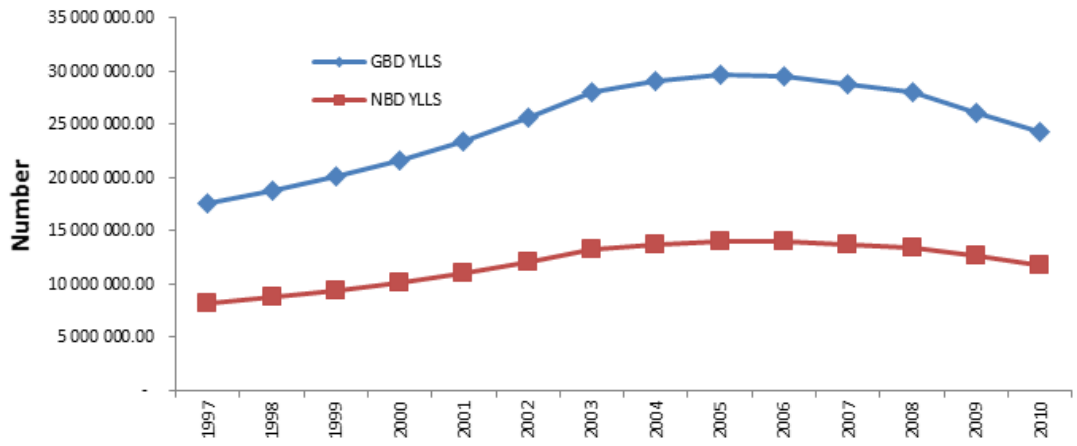

Figure 1: Comparison of estimated YLLs for South Africa by year from the 2nd SANBD 2010 and GBD 2010 studies.

Comparison of the 2nd SANBD YLLs with the GBD IHME YLLs revealed a similar finding as Brody *et al* (2007) (Figures 2-5). When comparing the YLLs by age group there is a distinct relationship for people 25 years and older (these age groups appear above the trend line) and for people < 25 years (these age groups appear below the trend line) (Figure 2).

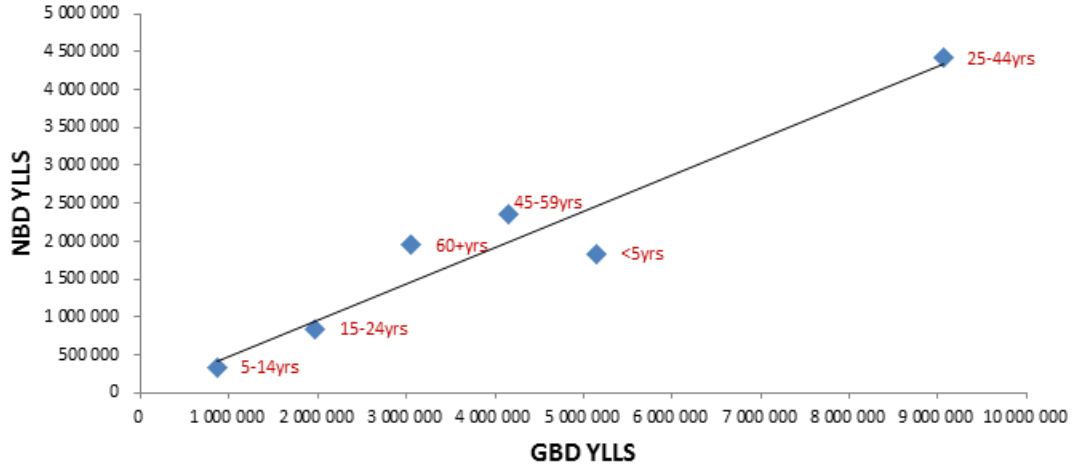

Figure 2: Comparison of YLLs by age group between the 2nd SANBD 2010 and GBD 2010 studies.

Another comparison between the 2nd SANBD YLLs and the GBD IHME YLLs was done to assess if the observed pattern by age are driven by specific causes (Figure 3 and 4). Figure 4 indicates a strong correlation for YLLs by single cause between the 2 studies, with HIV/AIDS appearing to be an outlier (Figure 3). When HIV/AIDS is removed the relationship seems less strong, with diseases related to older ages, such as ischaemic heart disease, diabetes mellitus and cerebrovascular disease appearing above the trend line, while diseases associated with children appearing below the trend line, such as meningitis, diarrhoeal disease and lower respiratory infections.

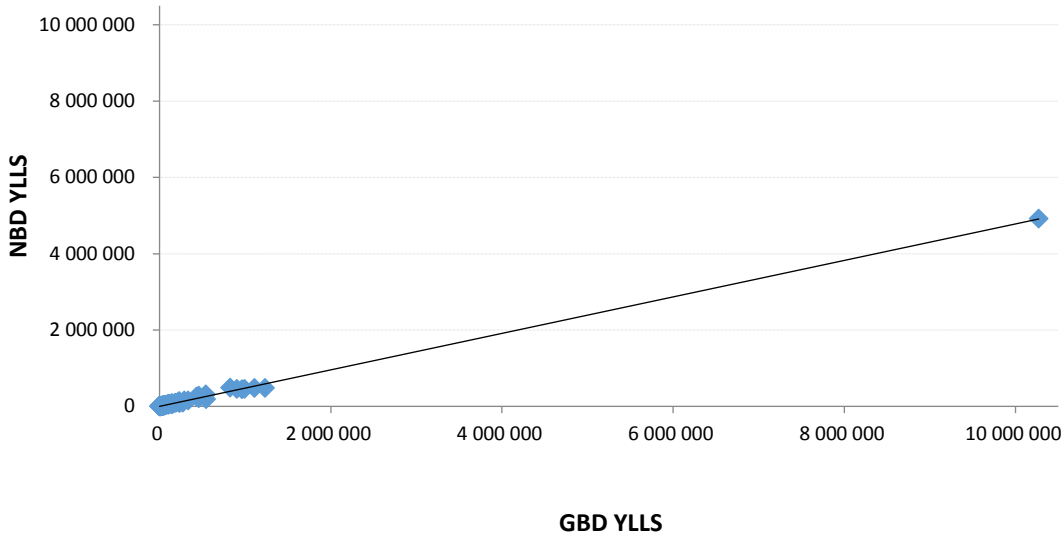

Figure 3: Comparison of YLLs by single disease between the 2nd NBD 2010 and GBD 2010 studies.

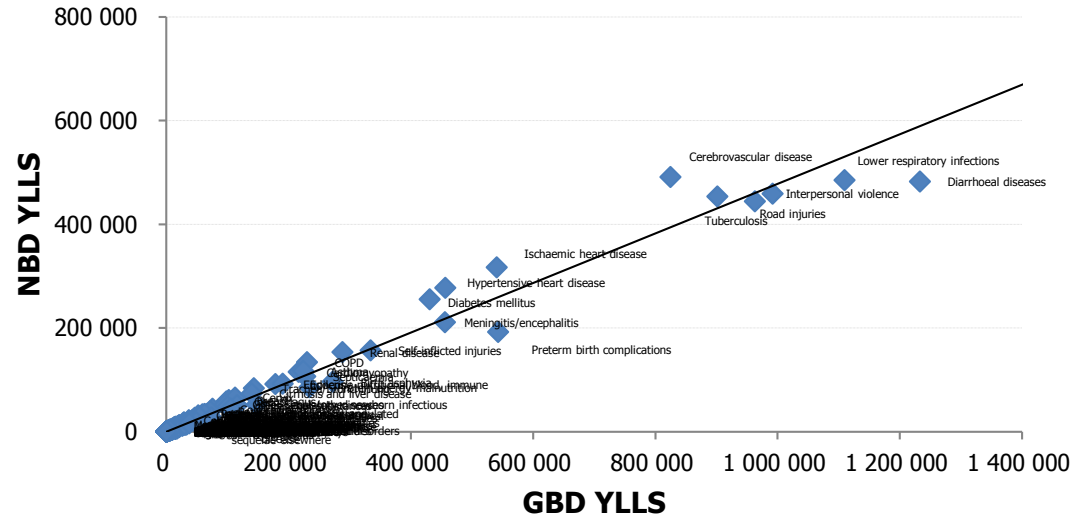

Figure 4: Comparison of YLLs by single disease (excluding HIV/AIDS) between the 2nd SANBD and GBD 2010 studies.

The ranking of the YLLs by single cause differs between the GBD and NBD, with the diseases associated with older age moving higher in ranking in the NBD study, such as Cerebrovascular disease and Ischaemic heart disease while the disease associated with children such as Diarrhoeal disease moving lower down in ranking for the NBD (Figure 5).

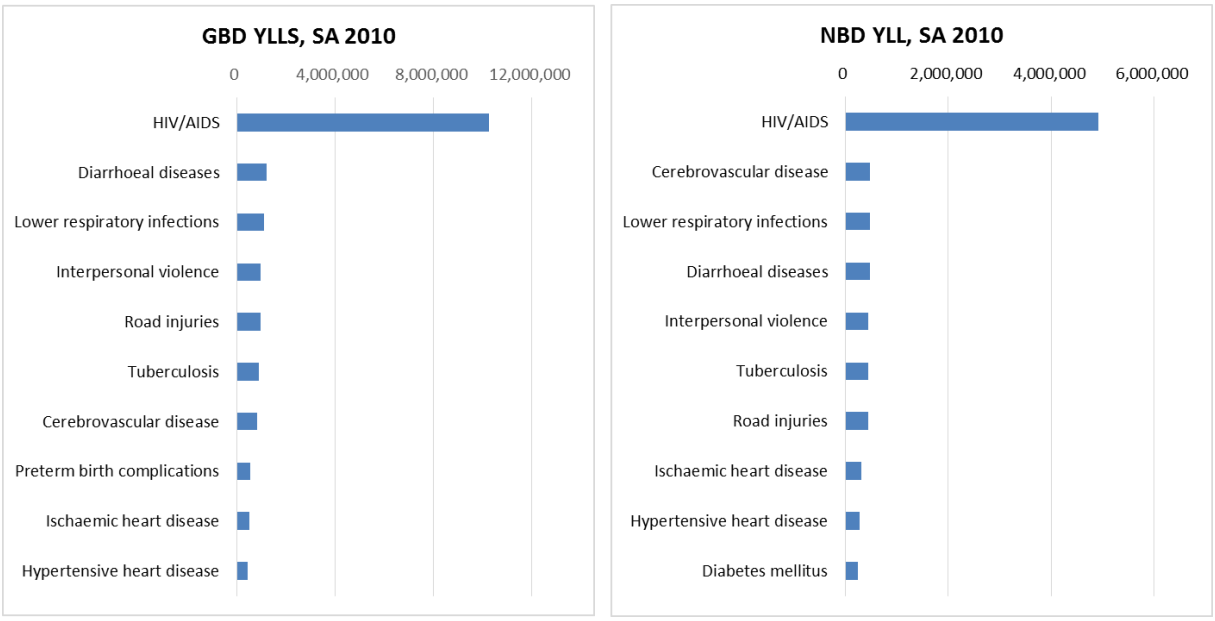

Figure 5. Comparison of YLLs ranking between the GBD 2010 and NBD 2010.

1.3 Value Choices for a DALY

1.3.1 Standard Life Expectancy

There are currently three options of standard life tables from which to choose the standard LE for the 2nd SANBD and 2nd SACRA study (Figure 6).

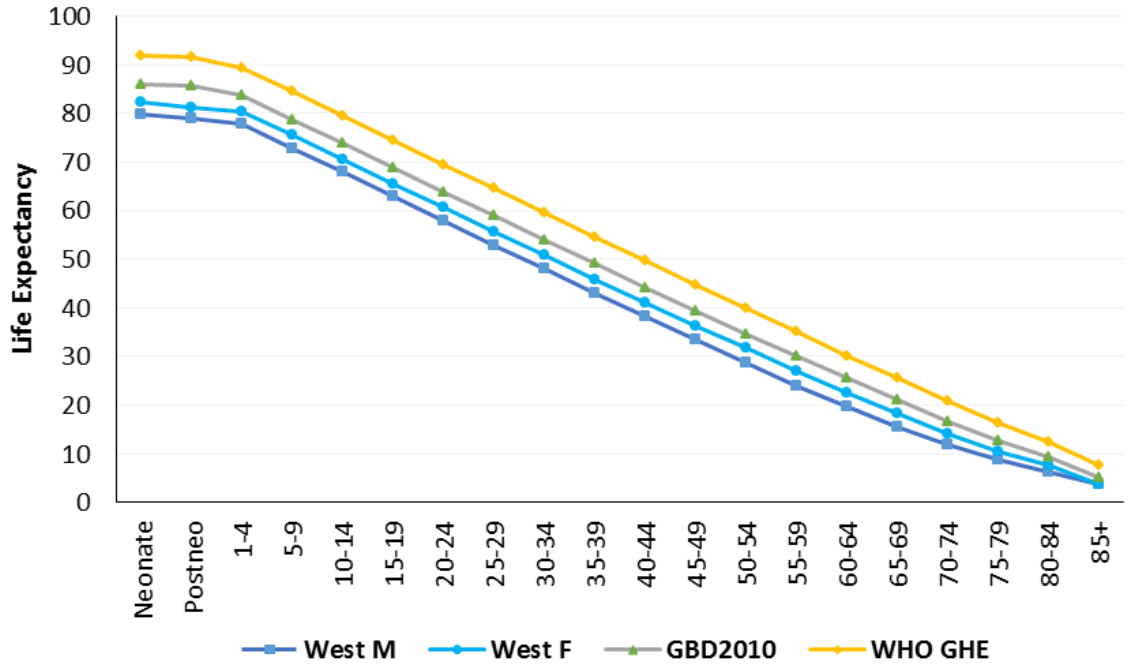

Figure 6: Comparison of different sources of LE

Source of data,World Health Organisation (2013a). West M = West Model 26 for males, West F = West Model 26 for females, GBD 2010 = Global Burden of Disease 2010, WHO GHE = World Health Organisation Global Health Estimates

The original 1990 GBD study as well as the WHO updates made use of level 26 of the West model life tables, which has slightly different values for males and females (Murray, 1994, World Health Organisation, 1999, World Health Organisation, 2000, World Health Organisation, 2002d, World Health Organisation, 2008). The level was selected on the basis of the highest observed LE of 82.5 for females in Japan in 1990 while the LE for males was set at 80, which is based on the observed male-female gap in LE in high income countries (Murray, 1994). This standard life table was used in the initial SA NBD study and has been used for the calculation of YLLs in the Western Cape mortality surveillance reports and the District Health Barometer.

The IHME GBD 2010 study noted that some countries had already exceeded the standard LE that was used in the original GBD studies. They therefore introduced a new standard life table based on the highest observed LE at each age group from all countries with a population higher than 5 million, regardless of sex (Murray *et al*, 2012). A single table is used for both males and females.

The WHO GHE study is using a LE projected for the year 2050 by the world population prospects 2012 (World Health Organisation, 2013b, United Nations Populations Division, 2013). This is a LE of 91.9 years which would be achieved by woman in Japan and North Korea. They argue that the current LE is not the maximum possible years a humans can reach in the absence of avertible deaths (United Nations Populations Division, 2013).

The West model 26 has the lowest LE of 80 at birth for males and 82.5 for females, while the WHO GHE has the highest LE of 91.7 at birth for persons.

1.3.2 Discounting

Discounting is a social-value choice which could be used in the DALY calculation. The YLL measures the future stream of life lost, and applying a discount to life lost in the future will give a net present value of years of life lost. This follows the convention that people value a year of life lived in the present higher than a year of life lived in the future.

Discounting of future benefits is often used in economic analysis, but much less so in demographic and epidemiological analyses of summary health measures (Murray and Acharya, 1997). However, discounting has been used extensively in burden of disease studies making use of a discounting rate of 3% per annum (Bradshaw *et al*, 2003, Murray and Lopez, 1996).

The IHME GBD 2010 study has used no discounting based on ethical arguments (Murray *et al*, 2012). They were guided by the view that a year of healthy life should be counted as equally important in terms of population health regardless of the year in which it is lived. The WHO GHE study has opted to follow the GBD IHME strategy by also dropping discounting from its updated estimates for the years 2000-2011 (World Health Organisation, 2013a).

1.3.2.1 Empirical investigation of varying discounting rates on YLLs

An empirical investigation by Brody *et al* (2007) for the Western Cape 2001-2004 mortality surveillance, using the West level 26 standard LE, showed that YLLs at a broad level were not affected by the different levels of discounting, however the exact positioning in the ranking for certain conditions associated with age were affected. As might be expected, discounting increased the ranking of conditions of high mortality rates in adults, and reduces the ranking of conditions affecting children (Table 2).

Furthermore a similar analysis was done on the 2nd SANBD study. YLLs were generated using different discounting rates (unpublished) and the West level 26 LE to assess the effect of different discounting rates on ranking of YLLs (Table 3). It can be seen that an increase in the discounting rate resulted in YLLs in childhood conditions ranking lower and adult conditions ranked higher for YLLs calculated with different discounting rates.

Table 2: Leading causes of deaths and YLLs, with and without discounting for males, Western Cape, Stats SA 2002

Rank	Deaths	%	No discounting	%	3% discounting	%
1	Undetermined injuries	18.2	Undetermined injuries	25.9	Undetermined injuries	23.7
2	Tuberculosis	10.2	Tuberculosis	11.2	Tuberculosis	11.6
3	Ischaemic heart disease	6.7	Ill-defined natural	5.0	Ill-defined natural	5.0
4	Stroke	5.5	Other perinatal	4.7	Ischaemic heart disease	4.7
5	Ill-defined natural	5.2	Ischaemic heart disease	3.7	Stroke	3.8
6	Chronic obstructive pulmonary disease	4.1	HIV/AIDS	3.4	HIV/AIDS	3.3
7	Diabetes mellitus	3.7	Stroke	3.0	Other perinatal	3.2
8	Trachea/bronchi/lung cancer	3.2	Chronic obstructive pulmonary disease	2.4	Chronic obstructive pulmonary disease	3.0
9	HIV/AIDS	2.5	Other endocrine and metabolic	2.1	Diabetes mellitus	2.6
10	Lower respiratory infections	2.5	Other perinatal respiratory conditions	2.1	Trachea/bronchi/lung cancer	2.4

Source: Adapted from (Brody et al, 2007)

Table 3: Leading causes of deaths and YLLs, with different discounting rates for males, 2nd SANBD

Deaths				No discounting			1.5% discounting		
Rank	**Cause**	**No of deaths**	**% of total deaths**	**Cause**	**No of YLLs**	**% YLLs**	**Cause**	**No of YLLs**	**% YLLs**
1	HIV/AIDS	101,269	33.1%	HIV/AIDS	4,255,061	38.1%	HIV/AIDS	3,049,569	38.1%
2	Interpersonal violence	15,788	5.2%	Interpersonal violence	754,602	6.8%	Interpersonal violence	528,440	6.6%
3	Road injuries	13,585	4.4%	Road injuries	626,002	5.6%	Road injuries	439,225	5.5%
4	Diarrhoeal diseases	9,983	3.3%	Diarrhoeal diseases	588,078	5.3%	Tuberculosis	377,065	4.7%
5	Lower respiratory infections	13,699	4.5%	Lower respiratory infections	523,061	4.7%	Diarrhoeal diseases	362,503	4.5%
6	Tuberculosis	15,462	5.1%	Tuberculosis	501,589	4.5%	Lower respiratory infections	352,166	4.4%
7	Cerebrovascular disease	15,593	5.1%	Cerebrovascular disease	282,644	2.5%	Cerebrovascular disease	234,951	2.9%
8	Preterm birth complications	3,462	1.1%	Preterm birth complications	276,705	2.5%	Ischaemic heart disease	211,189	2.6%
9	Ischaemic heart disease	13,564	4.4%	Ischaemic heart disease	253,556	2.3%	Self-inflicted injuries	173,095	2.2%
10	Self-inflicted injuries	5,380	1.8%	Self-inflicted injuries	243,277	2.2%	Preterm birth complications	161,198	2.0%

Rank		3% discounting			4.5% discounting		
		Cause	**No of YLLs**	**% YLLs**	**Cause**	**No of YLLs**	**% YLLs**
1		HIV/AIDS	2,306,127	38%	HIV/AIDS	1,835,705	38%
2		Interpersonal violence	390,010	6%	Interpersonal violence	308,215	6%
3		Road injuries	325,741	5%	Road injuries	257,282	5%
4		Tuberculosis	295,994	5%	Tuberculosis	237,149	5%
5		Lower respiratory infections	258,869	4%	Lower respiratory infections	198,078	4%
6		Diarrhoeal diseases	247,766	4%	Diarrhoeal diseases	183,128	4%
7		Cerebrovascular disease	199,900	3%	Cerebrovascular disease	159,886	3%
8		Ischaemic heart disease	179,571	3%	Ischaemic heart disease	144,162	3%
9		Self-inflicted injuries	129,284	2%	Self-inflicted injuries	102,765	2%
10		Meningitis/ encephalitis	110,934	2%	Meningitis/ encephalitis	87,476	2%

Source: Own calculations using the 2nd SANBD estimates

1.3.3 Age Weighting

Age weighting is a social-value choice, which can be used to calculate the DALY. Age weighting reflects social preferences, and values a year lived by people in their economically active ages higher than that of children or the elderly.

Age weighting was used in the NBD 2000 study (Bradshaw *et al*, 2003) as well as the GBD 1990 (Murray and Lopez, 1996) and the GBD results reported in WHO reports (World Health Organisation, 2000, World Health Organisation, 2002d, World Health Organisation, 2008). For the IHME GBD 2010 study age weighting was dropped from the DALY calculation (Murray *et al*, 2012), while the WHO has also dropped it from their updated estimates for the period 2000-2011 (World Health Organisation, 2013a). Age weighting does not seem to have a substantial influence on the ranking of causes based on YLLs. This is supported by the sensitivity analysis done in the Western Cape 2001-2004 mortality surveillance study, showing that the ranking of YLLs did not change much when calculating YLLs with and without age weighting (Brody *et al*, 2007) (Table 4).

Table 4: Leading causes of deaths and YLLs, with and without age weighting for males, Western Cape, Stats SA 2002

Rank	Deaths	%	No age weighting	%	Age weighting	%
1	Undetermined injuries	18.2	Undetermined injuries	25.9	Undetermined injuries	28.4
2	Tuberculosis	10.2	Tuberculosis	11.2	Tuberculosis	11.0
3	Ischaemic heart disease	6.7	Ill-defined natural	5.0	Other perinatal	5.5
4	Stroke	5.5	Other perinatal	4.7	Ill- defined natural	5.0
5	Ill-defined natural	5.2	Ischaemic heart disease	3.7	HIV/AIDS	3.6
6	Chronic obstructive pulmonary disease	4.1	HIV/AIDS	3.4	Ischaemic heart disease	2.9
7	Diabetes mellitus	3.7	Stroke	3.0	Stroke	2.4
8	Trachea/bronchi/lung cancer	3.2	Chronic obstructive pulmonary disease	2.4	Other perinatal respiratory conditions	2.4
9	HIV/AIDS	2.5	Other endocrine and metabolic	2.1	Other endocrine and metabolic	2.2

10	Lower respiratory infections	2.5	Other perinatal respiratory conditions	2.1	Homicide	2.1

Source:(Brody et al, 2007)

Age weighting has not been used to calculate YLLs in the Western Cape mortality surveillance reports, the District Health Barometer reports or the 2nd SANBD study.

1.3.4 Prevalence or Incidence YLDs

An incidence YLD measures the future stream of healthy life lost whereas a prevalence YLD measures the gap between states of ill health and full health for a given time period.

All the GBD studies prior to the 2010 study used incidence as a measure to calculate YLDs (Murray and Lopez, 1996, World Health Organisation, 1999, World Health Organisation, 2008, World Health Organisation, 2000, World Health Organisation, 2002d). The initial SA NBD study used the YLD/YLL ratios from the GBD 2000 estimates representative of the Afro E region to estimate incident YLDs (Bradshaw *et al*, 2003). The GBD 2010 study used a prevalence measure citing several advantages (Murray *et al*, 2012) including the decision to estimate co-morbidity in the 2010 study which would be much more challenging in an incidence measure. The WHO 2012 study has used the GBD 2010 YLD estimates, only modifying the disability weights and prevalence estimates for certain sequelae based on available WHO data (World Health Organisation, 2013a).

1.3.5 Disability Weights for YLDS

Disability weights are used to quantify the healthy years of life lost due to morbidity. A disability weight therefore allows the YLL and YLD components to be combined based on the common metric of time.

The GBD 1990 estimates were based on health state valuations made by a small group of health professionals and in response to wide criticism of the 1990 disability weights, the GBD 2010 study estimated empirical disability weights using household surveys in five countries and a web based survey (Salomon *et al*, 2012). For their 2013 DALY estimates, the GBD estimated new disability weights by combining the results of the 2010 survey with that of a survey

conducted in five European countries, which doubled the total number of respondents compared to the 2010 study (Salomon *et al*, 2015).

The disability weights derived by the WHO were based on the estimates of the GBD 2010 study with adjustments made to infertility, intellectual disability, vision loss, hearing loss, dementia, drug use disorders and low back pain based on expert opinion (World Health Organization, 2013a).

A household survey in an economically deprived local South African community was conducted to assess local health state preferences of the general public and to derive empirical disability weights (Neethling *et al*, 2016). Health state preferences were evaluated by using the pairwise comparison and time trade-off health state valuation techniques. There was a moderate correlation between the disability weights of this study and that of the GBD 2010 study (R^2=0.440, p<0.05), which indicates that not all health state valuations are universal as claimed by the GBD 2010 study. The study also yielded some counterintuitive results, for instance moderate dementia had lower disability weights than mild dementia.

2. Proposed DALY for SA NBD and SACRA

2.1 DALY classification

The 2nd SANBD and 2nd SACRA studies will measure burden of disease for South Arica making use of a hybrid DALY, since the YLL will be incidence based and the YLD prevalence based. According to Schroeder (2012) this DALY is preferable over an incidence and prevalence based DALY since it measures the burden of disease on a population for a specified time period.

For instance, to measure the burden of disease in 2010, both mortality and disability which occurred in 2010 would have to be reflected in the DALY. However the incidence based DALY reflects all mortality that occurred in 2010 but it does not reflect all disability experienced in 2010. This is because the incidence YLD measures only all new cases of disability that occurred in 2010 but does not reflect the disability that occurred in 2010 due to disease occurring before 2010.

The prevalence DALY on the other hand measures all disability of a population experienced in 2010 but since it requires all deaths that occurred in the past which would have contributed to YLLs in 2010 it does not reflect mortality experienced in 2010 only. It reflects additional health that would have been experienced by the population had everyone lived to their full expected lifespan and therefore does not infer the burden of mortality experienced in 2010.

The Hybrid DALY, which consists of an incidence YLL and a prevalence YLD can be used as a time period measure since it reflects all new cases of mortality experienced in 2010 plus all disability experienced in 2010. It therefore might not be justifiable as a theoretical construct. However, Schroeder (2012) argues that the role of the health system is to decrease disability and to keep people alive, which can best be represented by prevalence YLDs and incidence YLLs.

2.2 Standard life expectancy

The 2nd SANBD and 2nd SACRA studies will use the West model 26 life table since it has the lowest LE of the three models. This decision is based on the motivation that the lower LE of West model 26 is a more achievable goal for South Africa, since the observed LE in 2010 was 59. Also the West model 26 has been used in the Western Cape mortality surveillance reports and the District Health Barometer. Thus, to change the LE would require a convincing motivation.

2.3 Discounting

Discounting will be used to estimate YLLs in the 2nd SANBD and 2nd SACRA study as it prevents giving excess weights to conditions in younger ages, which is an important consideration for priority setting purposes. While there may be ethical arguments that a year of life lived at any time should have the same value, there is a strong economic argument that due to uncertainties in the future, years lived further at some future point should count less than the immediate period. The discounting rate has conventionally been 3% without a scientific basis, but for the 2nd SANBD and 2nd SACRA study a 1.5% discounting rate will be used. This discounting rate maintains a better balance of giving less weight to causes of death at younger ages as well as not being too far removed from the ranking of causes when not discounting compared to the 3% and 4.5% discounting rate. For instance, with the 3% and 4.5% discounting rates, preterm birth complications are displaced from the top 10 conditions, while it is ranked

10th with a 1.5% discounting rate and 8th with no discounting. Also in the hybrid DALY calculation, a 1.5% discounting rate of the YLLs gives more weight to fatal compared to non-fatal health loss (which is not discounted) in comparison to 3% and 4.5% discounting. This is important for priority setting purposes in a resource-constraint country such as South Africa where most of the burden is due to fatalities.

2.4 Age weighting

The 2nd SANBD and 2nd SACRA studies will not use age weighting since the YLL is already a form of age weighting and it seems unethical to value the life of young adults higher than people of other ages. This would also give greater weight to fatal compared to non-fatal health loss.

2.5 Incidence or Prevalence YLD

The 2nd SANBD and 2nd SACRA studies study will use a prevalence YLD. The reason for this is because the NBD study will make use of some of the GBD prevalence estimates to calculate local YLDs since it will be beyond the scope of the NBD study to model YLD estimates for all possible disease sequelae. It is also necessary to validate the GBD estimates with those diseases that will be modelled by the NBD.

2.6 Disability weight

The 2nd SANBD and 2nd SACRA studies study will use the GBD 2010 disability weights for its YLD calculations. The local disability weights derived from a household survey in a South African community were not considered since the study yielded some counterintuitive results which may indicate that the method used for the participants with a low level of education was too complex, while the WHO 2012 estimates were also not considered since it was based on the GBD 2010 estimates. A decision was made to use the latest GBD disability weight estimates, which was derived for their 2013 study.

Table 5 summarises the DALY value choices and decisions that were made for the 2nd SA NBD and CRA study.

2.7 DALY calculation

As there is limited morbidity data available to estimate years of life lived with a disability, GBD YLDs will be used to estimate DALYs for the 2nd SANBD study. Since there are noted differences between the mortality estimated for South Africa by the 2nd SANBD study and the GBD study, two DALY estimation methods were explored using the GBD YLDs. The first DALY was estimated by a simple addition of the NBD YLLs with the GBD YLDs. The second was an adjusted DALY estimated by applying the ratio of the GBD YLLs/NBD YLLs to the GBD YLDs to take into consideration the different mortality estimates from the two studies; these adjusted YLDs were added to the NBD YLLs to generate an adjusted DALY. The ranked top 10 DALYs differ using different methodologies as reported in Table 6.

Adjusting for the different mortality estimates does result in about 377 000 more DALYs, a different ranking of DALY causes and genito-urinary diseases replacing unipolar depressive disorder.

Table 5: Summary of DALY value choices for the 2nd SANBD and 2nd SACRA study

Value Choice	NBD 2010	Basis of Decision
Life Expectancy	West model 26	Lowest of 3 available models. South Africa had an LE of 59 in 2010, thus the lower LE is more achievable. The West model was also used in the Western Cape mortality surveillance project and the district health barometer.
Discounting	Discounting at 1.5% for YLL estimation	Prevents giving excess weight to conditions prevalent in younger ages. and reduces impact of future loss while also giving a better balance of fatal to non-fatal health loss. Estimates with no discounting will also be presented?
Age Weighting	No Age Weighting	Unethical to value young adults higher than others. The YLL is already a measure of age weighting
Prevalence or Incidence YLDs	Prevalence YLDs	The need to use GBD estimates prompted the decision to use Prevalence YLDs. To validate the GBD estimates.
Disability Weight	GBD 2013 Disability weights	Lack of reliable local estimates.

Table 6: Ranked top 10 DALYS using different estimation methods

Cause	DALY	%	Cause	AdjDALY	%
HIV/AIDS	5,730,480	29.2%	HIV/AIDS	534,2956	26.7%
Tuberculosis	825,002	4.2%	Tuberculosis	843,049	4.2%
Back and neck pain	711,724	3.6%	Back and neck pain	711,724	3.6%
Interpersonal violence	642,649	3.3%	Interpersonal violence	659,930	3.3%
Lower respiratory infections	632,779	3.2%	Road and other transport injuries	641,546	3.2%
Road and other transport injuries	610,601	3.1%	Lower respiratory infections	632,716	3.2%
Diarrhoeal diseases	584,782	3.0%	Genito-urinary diseases	591,714	3.0%
Cerebrovascular disease	566,466	2.9%	Diarrhoeal diseases	585,501	2.9%
Diabetes mellitus	472,008	2.4%	Cerebrovascular disease	574,118	2.9%
Unipolar depressive disorder	462,628	2.4%	Diabetes mellitus	490,114	2.5%
Total	**19,610,172**	**100.0%**	**Total**	**19,987,797**	**100.0%**

References

Bradshaw D, Groenewald P, Laubscher R, Nannan N, Nojilana B, Norman R, Pieterse D, Schneider M, Bourne D, Timæus I, Dorrington R, Johnson L. Initial Burden of Disease Estimates for South Africa, 2000. *S Afr Med J* 2003; 93**,** 682-88.

Brody L, Bradshaw D, Bourne D, Laubscher R. *Report on Western Cape Province mortality 1997-2002. An analysis of empirical cause of death data collected from Statistics South Africa from death notifications.,* Cape Town, South African Medical Research Council, 2007.

Murray CJL. Quantifying the burden of disease: the technical basis for disability-adjusted life years. *Bull World Health Organ* 1994; 72**,** 429-45.

Murray CJL, Acharya AK. Understanding DALYs (disability-adjusted life years). *Journal of Health Economics* 1997; 16**,** 703-30.

Murray CJL, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C, Naghavi M, Salomon JA, Shibuya K, Vos T, Wikler D, Lopez AD. GBD 2010: design, definitions, and metrics. *Lancet* 2012; 380**,** 2063-66.

Murray CJL, Frenk J. Summary measures of population health in the context of the WHO framework for health system performance assessment. *In:* Murray, CJL, Salomon, JA, Mathers, CD & Lopez, AD (eds.) *Summary measures of population health: Concepts, ethics, measurement and applications.* Geneva: World Health Organisation, 2002.

Murray CJL, 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,* Cambridge, MA, Harvard University Press on behalf of the World Health Organisation and The World Bank, 1996.

Neethling I, Jelsma J, Ramma L, Schneider H, Bradshaw D. 2016. Disability weights from a household survey in a low socio-economic setting: how does it compare to the global burden of disease 2010 study? *Global Health Action* [Online], 9. Available: http://dx.doi.org/10.3402/gha.v9.31754.

Salomon JA, Haagsma JA, Davis A, Maertens de Noordhout C, Polinder S, Havelaar AH, Cassini A, Devleesschauwer B, Kretzschmar M, Speybroeck N, Murray CJL, Vos T. Disability weights for the Global Burden of Disease 2013 study. *Lancet* 2015; 3**,** e712-23, doi: http://dx.doi.org/10.1016/S2214-109X(15)00069-8.

Salomon JA, Vos T, Hogan DR, Gagnon M, Naghavi M, Mokdad A, Begum N, Shah R, Karyana M, Kosen S. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the global burden of disease study 2010. *Lancet* 2012; 380**,** 2129-43, doi: http://dx.doi.org/10.1016/S0140-6736(12)61680-8.

Schroeder SA. Incidence, prevalence, and hybrid approaches to calculating disability-adjusted life years. *Population Health Metrics* 2012; 10.

United Nations Populations Division. *World population prospects - the 2012 revision,* New York, United Nations, 2013.

World Health Organisation. *The world health report 1999 - making a difference* [Online]. 1999. Geneva: World Health Organisation. Available: http://www.who.int/whr/1999/en/ [Accessed 8 April 2015].

World Health Organisation. *The World health report 2000 : health systems : improving performance,* Geneva, World Health Organisation, 2000.

World Health Organisation. *World Health Report 2002. Reducing Risks, Promoting Healthy Life.,* Geneva, WHO, 2002d.

World Health Organisation. *The Global burden of disease: 2004 update* [Online]. 2008. Geneva: World Health Organisation. Available:

http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf [Accessed 1 April 2015].
World Health Organisation. *WHO methods and data sources for global burden of disease estimates 2000-2011 (Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2013.4),* Geneva, World Health Organisation, 2013a.
World Health Organisation. *WHO methods and data sources for life tables 1990-2011 (Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2013.1),* Geneva, World Health Organisation, 2013b.