The disability adjusted life years due to stroke in South Africa in 2008

Melanie Y. Bertram1,2*, Judith Katzenellenbogen3, Theo Vos4, Debbie Bradshaw5, and Karen J. Hofman1,2

Background South Africa is experiencing epidemiological transition, with the burden of chronic diseases increasing. Stroke is currently the second leading cause of death in South Africa; however, limited data are available on incidence, prevalence and resulting disability. Quantifying the epidemiological parameters and disease burden is important in the planning of health services.

Aims To synthesize the data surrounding stroke in South Africa and calculate disability adjusted life years attributable to stroke in South Africa in 2008.

Methods We undertook a systematic review to identify studies on the prevalence and mortality of stroke in South Africa. We used the DisMod program to calculate missing epidemiological parameters, in particular incidence and duration. Using these values, we calculated the burden of disease in years of life lost (YLL), years lived with disability (YLD) and disability adjusted life years (DALY).

Results Data on prevalence and mortality of stroke in South Africa are scarce. We estimate there are 75 000 strokes in South Africa each year, with 25 000 of these fatal within the first month. The burden of disease due to stroke in South Africa was 564 000 DALYs. Of this, 17% is contributed by YLD (14–20% in sensitivity analysis).

Conclusions This study provides information on prevalence, incidence and disease burden of stroke at the national level in South Africa. The results of this analysis will enable further work on priority setting and health service planning for primary and secondary prevention of stroke in South Africa.

Key words: African, DALY, developing countries, economics, epidemiology, stroke

Introduction

Stroke is the second leading cause of death worldwide, with estimates that it is responsible for more than 5 million deaths each year (1). More than 80% of these deaths occur in low- and middle-income countries. South Africa is in the midst of an epidemiological transition, simultaneously facing a rising burden of non-communicable diseases along with high levels of infectious and maternal and child health conditions, compounded by a staggering HIV prevalence.

In 2000, stroke was the third leading cause of death in South Africa after HIV/AIDS and ischemic heart disease (2). Risk factor prevalence for stroke is high. South Africans consume a high salt diet (3) and 29% of men and 56% of women are overweight or obese (4). More than 50% of stroke is attributable to hypertension (5). The prevalence of hypertension is high (24·4%) in South Africa (6) with only 38% of those diagnosed with hypertension controlled by medication, due to poor adherence (7). Population-wide strategies to reduce the prevalence of risk factors are not in place.

The burden of stroke comes not just as mortality, but also as high health and economic burden caused by non-fatal stroke. In 1991, a study found that the annual cost of cardiovascular disease in South Africa (including stroke, ischemic heart disease, peripheral vascular disease and thromboembolic conditions) was 4·1 billion to 5·0 billion Rands, not including rehabilitation (8). Adjusting to 2011 values, the current cost of vascular disease would be 13–16 billion Rands annually. Given the increasing incidence of chronic diseases due to the epidemiological transition, and development of more expensive treatment regimens, this is likely to substantially underestimate the true cost of vascular disease to South Africa.

The health burden of stroke in South Africa was first estimated in the Medical Research Council report on the Initial Estimates of the Burden of Disease in South Africa, 2000, using the Disability Adjusted Life Year (DALY) metric. This composite burden of disease index combines fatal and non-fatal burden in a single measure. It is calculated from the sum of Years of Life Lost (YLL), the mortality component and Years Lived with Disability (YLD), the morbidity component. However, the main focus of the report was on the disease burden due to premature mortality, with the morbidity component estimated using regional estimates from the World Health Organization. Regional estimates were used due to the paucity of national population-based epidemiological stroke data required to calculate YLD, in particular stroke occurrence and post-stroke mortality risk.

Aims/hypothesis

This paper aimed to undertake a systematic review of available national estimates of the epidemiology of stroke, and provide updated estimates of the burden of stroke in DALYs, using South Africa data wherever possible.
Methods

We modeled disability separately for those who die within 28 days of stroke and those who survive beyond this initial high-mortality period. Those who die within 28 days contribute only a small proportion of overall disability. Disability is calculated as the product of incidence, severity and average duration.

We undertook literature reviews using PubMed to search for articles published since 1990 providing estimates of two epidemiological parameters most likely to be available in the South African or similar setting, namely stroke prevalence and post-stroke mortality risk. Titles and abstracts of identified articles were screened for their relevance. Those deemed relevant then underwent full text screening. For prevalence, articles were excluded if they described in-hospital prevalence only, and if they were reviews or letters. For mortality, articles were excluded if they measured only in-hospital mortality (not population-based), used vital registration data from Statistics South Africa (we had access to the primary data source), or were review articles (to avoid replication with primary publications of data).

Prevalence

Two sources of data reporting stroke prevalence in South Africa were identified. The first was a population-based prevalence and mortality study undertaken in the Agincourt sub-district of Mpumalanga Province. However because it was undertaken in a small rural area, it was not representative of stroke prevalence and mortality for South Africa as a whole and could not be used in this study (9). Instead, self-report data from the South African Demographic Household Surveys (SADHS) in 1998 and 2003 (7,10) were used. Self-report data are not ideal for measuring prevalence due to recall bias. However, SADHS was a population-wide, representative survey and, therefore, was considered the best data source for our analyses. The question asked to measure stroke prevalence in the 2003 SADHS was ‘Has a doctor or nurse or health worker at a clinic or hospital told you that you have or have had any of the following conditions’: Stroke was one of the conditions explicitly prompted for. In the 1998 DHS, the same question was asked, with a follow-up question querying if the stroke was within the previous year or longer than 1 year ago. This methodology may underestimate prevalence because it requires a diagnosis given by a clinician/health worker at a health facility, thus excluding people with chronic conditions who were unable to attend a health service. A study by based in Mpumalanga province found that of all people complaining of a chronic illness, 38% did not have a clinical diagnosis, generally due to being unable to access health care (11). As a conservative assumption, we increased the DHS prevalence by half the proportion (19%) reported in this study. Sensitivity analysis was undertaken to determine the impact of using this assumption. Thus estimates varied by assuming: (1) that the DHS prevalence was correct; (2) that the under-estimate was 19%; and (3) that the under-estimate was 38%.

Mortality risk in 28-day stroke survivors

Due to the high risk of mortality in the first 28 days following a stroke, prevalence reflects only those who survive this period. Along with the prevalence, we require a measure of mortality risk after 28 days. Our literature review did not identify any South African studies on either relative risk of mortality or case-fatality in 28-day survivors of stroke. A previously published systematic review on epidemiology of stroke in sub-Saharan Africa identified that mortality is similar to that seen in high-income countries (12). We use relative risk of mortality from the Australian Burden of Disease and Injury study (13,14). As background mortality in South Africa is higher than in Australia, the implicit assumption here is that the case fatality rate in South Africa is higher than in Australia.

Derivation of incidence and duration using computer-based modeling

The epidemiological parameters required to calculate YLD are not always available. DisMod II is a specialized software tool which creates an internally consistent set of epidemiological parameters for a condition given three parameters as inputs (15). In DisMod remission is defined as ‘cure’, hence no remission is possible when modeling stroke survivors. Consequently, prevalence, relative risk of mortality after 28 days and a remission rate of zero were used in DisMod yielding estimates of incidence and duration as outputs. Inputs used in the DisMod calculation are shown in Table 1.

Disability weights

Disability weights were calculated using proportions of stroke patients at each Rankin Scale rating from a South African study (16), along with a translation of each Rankin Scale to a Disability Weight (17) (see Table 2). The South African study was carried out in Durban, KwaZulu Natal. Patients were recruited into a stroke database from 1992–1998. A retrospective analysis was then undertaken of all patients aged 15–40 to establish their disability as a result of the stroke. The modified Rankin Scale was translated into disability weights using the person trade off methods. This method involved health care professionals valuing interpersonal comparisons of individuals with different disease states, to establish relative disability (17). We assume a weighted average disability weight, by multiplying each disability weight by the proportion of the population it represents.

<table>
<thead>
<tr>
<th>Prevalence</th>
<th>RR mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>0–14</td>
<td>0.00000</td>
</tr>
<tr>
<td>15–24</td>
<td>0.00000</td>
</tr>
<tr>
<td>25–34</td>
<td>0.00864</td>
</tr>
<tr>
<td>35–44</td>
<td>0.00617</td>
</tr>
<tr>
<td>45–54</td>
<td>0.02469</td>
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<tr>
<td>55–64</td>
<td>0.02469</td>
</tr>
<tr>
<td>65–74</td>
<td>0.02840</td>
</tr>
<tr>
<td>75–84</td>
<td>0.02840</td>
</tr>
<tr>
<td>85+</td>
<td>0.02840</td>
</tr>
</tbody>
</table>
YLD

We calculated the YLD due to stroke in South Africa using equation 1. YLD are discounted by 3% per year, and age weighting is incorporated for consistency with GBD 2004 estimates and SA BOD 2000 estimates.

Incidence calculated in DisMod reflects those who survive the initial increased mortality period. To complete our calculation of the non-fatality disease burden we also need to calculate the cases that die within 28 days. Two studies were identified in South Africa that indicated 1-month mortality rates. Both are hospital-based studies, one from 1986–1987, which reported a first-month case fatality of 33% (18), the other from 1984/5 reported one-month case-fatality of 34% (19). The weighted average of these values gave a 28-day case fatality rate of 33%. Using this in equation 2, calculated the incidence of cases fatal within 28 days. Assuming an average duration of 1 week, and the most severe disability weight, the burden of cases fatal within 28 days was calculated and added to those surviving beyond 28 days.

Equation 1:

\[
\text{Total incidence} = \frac{[28 \text{ day incidence}]/(1 - 28 \text{ day CFR})] - 28 \text{ day incidence}}{28 \text{ day incidence}}
\]

Measuring the fatal burden of disease

Mortality data used in this study were based on estimates produced by the Medical Research Council (MRC) Burden of Disease (BOD) unit for 2008 (Unpublished data, MRC BOD unit). South African mortality data is routinely collected by the Home Affairs office. However, undercounting and misclassification are problematic despite great improvement over the last 20 years (2,20–22). The MRC BOD group deals with this by redistributing deaths coded to ill-defined causes and correcting for the anticipated undercounting (23). In 2007 the MRC BOD group published estimates of YLL in South Africa in 2000 based on this corrected mortality data. Estimates for 2008 are expected to be published by the end of 2011. For this analysis, we use the currently unpublished 2008 stroke deaths to calculate YLL. YLL and YLD are age weighted and discounted by 3% per year. The addition of the fatal and non-fatal components of the burden of disease gives us DALYs.

Results

Literature review

The literature search for stroke mortality identified 92 articles, of which 4 were considered potentially useful for this analysis (Fig. S1). Two of these studies reported 1-month mortality rates, one contained mortality data from a rural demographic surveillance site and the fourth was the MRC BOD unit mortality data from 2000. Ultimately, the rural site data were excluded as it was not representative of the South African population at a national level.

The literature search for stroke prevalence identified 157 articles, of which 4 were considered potentially useful for this analysis (Fig. S2). Two of these studies reported the same data from a rural demographic surveillance site, which was excluded as it was not representative of the population as a whole. Two were hospital registers used for their information on stroke sub-types.

Incidence and prevalence

We estimated there were approximately 75 000 new strokes in South Africa in 2008. Of these, approximately 25 000 were fatal within the first 28 days. In 2007, there were 350 000 people living with stroke in South Africa, of which 35% had moderate to severe disability as a result of their stroke. The incidence of stroke calculated using DisMod is shown in Table 3. The incidence from the World Health Organization Global Burden of Disease study, for the Africa E region, which South Africa falls within, is also shown. The incidence calculated in this study is substantially lower than that reported for the Africa region overall, but with differing age patterns. Our results show higher incidence rates at younger ages and less of an increase with age than in the regional estimates.

Burden of stroke

The current study estimates 580 000 DALYs across all age and sex groups (Fig. 1). The total number of YLL was 484 000 and YLD 95 000. The 2000 SA BOD study calculated a total of 350 000 DALYs attributable to stroke, and the WHO GBD 2004 estimated 431 000 DALYs. These estimates assume 19% of strokes in South Africa are untreated, half of a proportion reported as untreated chronic disease in South Africa. YLD are lower by 18% if assuming no stroke is untreated and would be higher by 30% if we assume the same proportion untreated as reported for all chronic conditions. The DALY varies by 3-5% below and 4-5% above the main estimate.

Discussion

The total number of DALYs calculated shows similar results to the World Health Organization country level estimates for South Africa for 2004, showing 431 000 DALYs due to stroke, compared to the 412 000 calculated in this study for 2008.

The main strength of this analysis is its use of largely local data, with the exception of the relative risk of mortality following stroke. This differs from the SA BOD study, which estimated YLD based on WHO estimates, and from the WHO estimates which
used globally available data to estimate disease burden for each WHO sub-region. Despite this strength, there are a number of weaknesses in the data used. The use of self-report prevalence data, albeit increased to account for those not diagnosed, may under report how many people have had stroke. It is possible that strokes that did not lead to disability might be differentially not reported, thus impact the distribution of cases by stroke severity. There may be an overall underestimate of stroke cases; however, those not counted would contribute little to the morbidity caused by stroke. Information on stroke severity in this analysis relied on a study of stroke in patients aged 15–49. Although this does not represent the full age range of stroke patients in South Africa, the average long term disability weight calculated from this data, 0-28, is comparable to long term disability weights used elsewhere (0-25–0-35 in Australia depending on age and sex, 0-17–0-38 in Vietnam depending in age and sex) (24,25).

Using in hospital mortality for the 28-day case fatality rate is not ideal. There are two different ways the 28-day CFR may be impacted. Only the most severe strokes in South Africa will be admitted to hospital, with more of these likely to die within the first month, thus biasing the 28-day case fatality rate upwards. However, people may die from new cases of stroke before reaching the hospital, particularly in rural areas where access to health care facilities may be limited (26). We do not believe this has a significant impact on the results for this analysis. When looking at the total number of strokes in South Africa to evaluate the potential impact of preventive interventions, these early deaths become more critical to identify.

There was one prevalence estimate from the literature; however, this was from a small sample in a rural area (27). Participants in an annual census were asked a screening question to identify people who may have had a stroke. Diagnosis of stroke was made by a neurologist, in the absence of imaging technology. Prevalence was lower than in the DHS data used in our analysis. Mortality due to stroke in the same rural population was also lower than the national estimate. This may indicate that prevalence of stroke, and potentially other chronic conditions is lower in rural, low SES areas. Studies of the epidemiology and burden of disease in South Africa may need to consider stratification by urban and rural populations to take account for these differences, to more accurately show the current burden of stroke in different provinces or districts of SA. However limited data may prevent analysis at this level. An analysis of the demographic surveillance site in Agincourt, where prevalence and mortality data are collected, may provide insight into stroke epidemiology in poor rural areas (9,26).

Future research in South Africa should focus on obtaining population representative data that can be used in burden of disease analysis. Population level prevalence and/or incidence studies that are representative of the diverse population of South Africa may need to consider stratification by urban and rural populations to take account for these differences, to more accurately show the current burden of stroke in different provinces or districts of SA. However limited data may prevent analysis at this level. An analysis of the demographic surveillance site in Agincourt, where prevalence and mortality data are collected, may provide insight into stroke epidemiology in poor rural areas (9,26).

Fig. 1 YLL, YLD and DALY attributable to stroke in South Africa. Error bars indicate sensitivity analysis surrounding prevalence input into analysis.

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| Table 3 Incidence of stroke per 100 000 population in South Africa in 2008, by age and sex |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                                | Total incidence | 28-day fatal incidence | Incidence of 28-day survivors | AFRO-E total incidence, GBD 2000 |
|                                | Male | Female | Male | Female | Male | Female | Male | Female |
| 0–4                            | 0    | 0      | 0    | 0      | 0    | 0      | 2    | 3      |
| 5–14                           | 0    | 0      | 0    | 0      | 0    | 0      | 1    | 0      |
| 15–29                          | 79   | 143    | 26   | 47     | 53   | 95     | 5    | 5      |
| 30–44                          | 412  | 423    | 137  | 141    | 275  | 283    | 89   | 30     |
| 45–59                          | 665  | 384    | 221  | 128    | 444  | 256    | 274  | 329    |
| 60–69                          | 583  | 609    | 194  | 203    | 389  | 407    | 781  | 1115   |
| 70–79                          | 595  | 826    | 198  | 275    | 397  | 551    | 1693 | 2539   |
| 80+                            | 1384 | 2520   | 460  | 839    | 923  | 1681   | 2995 | 5233   |
| All ages                       | 465  | 615    | 155  | 204    | 310  | 410    | 730  | 1157   |

Chronic disease has been recognized in South Africa as one of the contributors to the ‘quadruple burden of disease’, alongside...
HIV/AIDS, maternal and child health and injuries. A South African Chronic Disease Summit took place in November 2011. Arising from this meeting was a strong desire for locally produced information on Burden of Disease in South Africa, and of the impacts of preventive interventions on disease prevalence.

This study provides the first locally produced burden of disease estimates for stroke, which can provide a strong basis for evidence based decision making. This data will also provide a platform for work to establish cost-effective prevention and treatment options in South Africa. Given the high burden of stroke in South Africa, a more concerted population wide approach to stroke prevention is needed to reduce the burden. Cost-effectiveness analyses elsewhere indicate population level interventions are more cost-effective than interventions targeted at high-risk individuals (28). Analyses of this kind have not been undertaken in South Africa. Local data may help to support the government’s approach to cardiovascular disease prevention in the future, particularly within the context of a forthcoming move to a Nationalized Health Insurance scheme in South Africa.

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References


Supporting Information

Additional Supporting Information may be found in the online version of this article:

Fig. S1 Literature search results for stroke mortality studies.
Fig. S2 Literature search results for stroke prevalence studies.