Estimating the burden of disease attributable to diabetes in South Africa in 2000

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Objectives. To estimate the burden of disease attributable to diabetes by sex and age group in South Africa in 2000.

Design. The framework adopted for the most recent World Health Organization comparative risk assessment (CRA) methodology was followed. Small community studies used to derive the prevalence of diabetes by population group were weighted proportionately for a national estimate. Population-attributable fractions were calculated and applied to revised burden of disease estimates. Monte Carlo simulation-modelling techniques were used for uncertainty analysis.

Setting. South Africa.

Subjects. Adults 30 years and older.

Outcome measures. Mortality and disability-adjusted life years (DALYs) for ischaemic heart disease (IHD), stroke, hypertensive disease and renal failure.

Results. Of South Africans aged ≥30 years, 5.5% had diabetes which increased with age. Overall, about 14% of IHD, 10% of stroke, 12% of hypertensive disease and 12% of renal disease burden in adult males and females (30+ years) were attributable to diabetes. Diabetes was estimated to have caused 22 412 (95% uncertainty interval 20 755 - 24 872) or 4.3% (95% uncertainty interval 4.0 - 4.8%) of all deaths in South Africa in 2000. Since most of these occurred in middle or old age, the loss of healthy life years comprises a smaller proportion of the total 258 028 DALYs (95% uncertainty interval 236 856 - 290 849) in South Africa in 2000, accounting for 1.6% (95% uncertainty interval 1.5 - 1.8%) of the total burden.

Conclusions. Diabetes is an important direct and indirect cause of burden in South Africa. Primary prevention of the disease through multi-level interventions and improved management at primary health care level are needed.

from cardiovascular disease that is associated with diabetes or diabetes-related renal failure that is misclassified. Although not included in the global risk factor assessment,12 diabetes was identified by the South African National Department of Health as a risk factor of major concern. The aim of the present study is to quantify the burden of disease in terms of deaths and loss of healthy life years (DALYs) attributed to diabetes by sex and age group in South Africa for the year 2000.

Methods

Comparative risk assessment (CRA) methodology developed by the World Health Organization13,14 was used. In addition to the burden directly attributed to diabetes estimated in the South African National Burden of Disease study for 2000, the additional attributable burden is assessed by calculating the attributable fraction from estimates of the prevalence of diabetes in the population and the relative risk (RR) of selected health outcomes. Attributable burdens were calculated by applying the relevant population attributable fractions (PAFs) to the estimate of current disease burden.

The prevalence of diabetes was estimated as a weighted average of the results from selected studies to represent subpopulations.15-18 The only data available to represent black Africans living in a rural area were collected in the former homeland of QwaQwa.3 The study by Levitt et al.5 demonstrated a clear increase in the prevalence of diabetes associated with the length of stay in the urban area, and the 1998 South African Demographic and Health Survey (SADHS)14 showed that the prevalence of overweight and obesity among black Africans was twice as high in the urban setting compared with the rural setting. The prevalence data from QwaQwa were surprisingly high and similar to the urban township of Mangungu. This could be attributed to the close proximity of the former homeland to the urban setting. It was therefore decided to conservatively assume that the prevalence of diabetes in the rural area was half that estimated for the urban black population. Population weights for urban black Africans, rural black Africans and the other population groups were based on the Actuarial Society of South Africa population estimate for the year 2000 by age and sex. The population group classification is used in this article to demonstrate differences in the risk factor profile and the subsequent burden. Data are based on self-reported categories according to the population group categories used by Statistics South Africa. Mentioning such differences allows for a more accurate estimate of the overall burden and may assist in higher effectiveness of future interventions. The authors do not subscribe to this classification for any other purpose. The prevalence of diabetes in adults aged 30+ we assumed that the prevalence of exposure and RR is the relative risk of disease in the exposed versus unexposed group. PAFs were then applied to revised South African burden of disease estimates for 2000 with methods and assumptions described elsewhere20 to calculate attributable burden (number of deaths, years of life lost (YLLs) due to premature mortality, years of life lived with disability (YLDs) and DALYs). Because of data limitations, all diabetes burden in adults 30 years and older was assumed to be type 2 diabetes.

Monte Carlo simulation-modelling techniques were used to present uncertainty ranges around point estimates that reflect all the main sources of uncertainty in the calculations. We used the @RISK software version 4.5 for Excel,25 which allows multiple recalculations of a spreadsheet, each time choosing a value from distributions defined for input variables. For the prevalence of diabetes in adults aged 30+ we assumed that the weighted national estimates could vary by 20%, and specified a triangular distribution with three points (minimum, most likely and maximum). For the RR input variables we specified a normal distribution around the logged point estimate and its standard error derived from the published values and their 95% confidence intervals (CIs) (Table I). For each of the output variables (namely attributable burden as a percentage of total

The outcomes assessed were ischaemic heart disease (IHD), stroke, hypertensive disease and renal failure (nephritis/ nephrosis excluding hypertensive renal disease). According to International Classification of Diseases (ICD) rules,16 diabetes should be recorded as the underlying cause of death from end-stage renal failure caused by diabetes. As extensive misclassification has been observed as a result of incomplete certification in other settings,27,28 and the need for better certification has been identified in South Africa,17 it was assumed that a proportion of the deaths ascribed to nephritis/nephrosis were likely to have resulted from diabetes. A review of the literature provided several estimates of the RRs of these outcomes.20-25 However, the Asia Pacific Cohort Studies Collaboration34 includes most of the prospective observational studies conducted in both Indian and Caucasian populations in the region. It provides reliable evidence on the effects of a variety of modifiable risk factors, including diabetes, on the risks of major cardiovascular diseases and other common causes of death in populations from this region. The age- and sex-specific hazards (Table I) re-categorised to match the burden of disease age groups were used in this study. As there were no relative risks published for hypertensive disease, the RR for all cardiovascular disease was used.

Customised MS Excel spreadsheets were used to calculate the attributable burden using the PAF formula for each age interval:

\[
\text{PAF} = \frac{P \times (R - 1)}{P \times (R - 1) + 1}
\]

where \(P\) is the prevalence of exposure and \(R\) is the relative risk of disease in the exposed versus unexposed group. PAFs were then applied to revised South African burden of disease estimates for 2000 with methods and assumptions described elsewhere20 to calculate attributable burden (number of deaths, years of life lost (YLLs) due to premature mortality, years of life lived with disability (YLDs) and DALYs). Because of data limitations, all diabetes burden in adults 30 years and older was assumed to be type 2 diabetes.
Results

The estimated prevalence of diabetes among South African adults 30 years and older was 5.5% in 2000 and varied by age and sex, as can be seen from Fig. 1. The prevalence increased with age for both males and females, and although it was similar for males and females in the younger age groups, there was a marked difference over the age of 60 years.

The prevalence of diabetes varied by population group, as shown in Table II. The Indian population group had the highest prevalence of diabetes. The prevalence was consistently higher for women of all population groups except for Indians. The prevalence of diabetes was also highest in the older age groups (60 years and older). In Indians there was also a marked increase in the 45 - 49-year age groups for both men and women.

Table III gives a summary of the attributable burden in terms of deaths and DALYs resulting from each of the related conditions. Compared with other conditions, the PAFs were highest for IHD for both males and females. In adults 30 years and older, diabetes caused 13 166 deaths in 2000 directly and a further 9 246 could be attributed through IHD, stroke, hypertensive disease and renal failure. Thus 22 412 (95% uncertainty interval 20 755 - 24 872) or 4.3% (95% uncertainty interval 4.0 - 4.8%) of all deaths were attributed to diabetes in South Africa in 2000. Almost half of the attributable deaths occurred among adults of working age: 47.2% of those who died were under 65 years. Fig. 2 shows the age and sex distribution of the deaths and highlights that the peak burden for men was in the age range 45 - 59 years, while for women it was higher and occurred in the age range 60 - 69 years. There were more attributable deaths in females than in males, and overall diabetes accounted for 5.7% of all female and 3.0% of all male deaths in South Africa in 2000.

A total of 258 028 DALYs (95% uncertainty interval 236 856 - 290 849) were attributable to diabetes. Although IHD accounted for more deaths than stroke in females, the DALYs for stroke were higher than those for IHD because of the greater disability component (YLDs) for stroke. Since most diabetes-related deaths occur in the elderly, the loss of life years accounts for a lower proportion of the total DALYs than deaths, i.e. 1.6% (95% uncertainty interval 1.5 - 1.8%) of the total.

Table I. Adjusted hazard ratios for cardiovascular and renal disease

<table>
<thead>
<tr>
<th>Sex/Age (years)</th>
<th>Hazard ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All ischaemic heart disease events (I20-I25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>2.03</td>
<td>(1.60 - 2.59)</td>
</tr>
<tr>
<td>Females</td>
<td>2.54</td>
<td>(1.84 - 3.49)</td>
</tr>
<tr>
<td>&lt; 60</td>
<td>4.38</td>
<td>(2.63 - 7.31)</td>
</tr>
<tr>
<td>60 - 74</td>
<td>2.44</td>
<td>(1.84 - 3.22)</td>
</tr>
<tr>
<td>75+</td>
<td>1.57</td>
<td>(1.14 - 2.16)</td>
</tr>
<tr>
<td>Cerebrovascular deaths (I60-I69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>2.04</td>
<td>(1.46 - 2.84)</td>
</tr>
<tr>
<td>Females</td>
<td>2.00</td>
<td>(1.37 - 2.92)</td>
</tr>
<tr>
<td>&lt; 60</td>
<td>2.57</td>
<td>(1.00 - 6.59)</td>
</tr>
<tr>
<td>60 - 74</td>
<td>2.69</td>
<td>(1.91 - 3.80)</td>
</tr>
<tr>
<td>75+</td>
<td>1.30</td>
<td>(0.86 - 1.96)</td>
</tr>
<tr>
<td>Non-fatal cerebrovascular events (I60-I69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male + female</td>
<td>2.09</td>
<td>(1.65 - 2.64)</td>
</tr>
<tr>
<td>All cardiovascular disease (I00-I26, I28-I84, I86-I99, J81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 60</td>
<td>3.47</td>
<td>(2.30 - 5.21)</td>
</tr>
<tr>
<td>60 - 74</td>
<td>2.27</td>
<td>(1.87 - 2.75)</td>
</tr>
<tr>
<td>75+</td>
<td>1.49</td>
<td>(1.20 - 1.84)</td>
</tr>
<tr>
<td>Renal disease excluding cancer (N00-N19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male + female</td>
<td>2.93</td>
<td>(1.70 - 5.04)</td>
</tr>
</tbody>
</table>

Source: Asia Pacific Cohort Studies Collaboration;34 ICD-10 codes.36

Fig. 1. Estimated prevalence of diabetes by age and sex, South Africa, 2000.
Discussion

This study estimated that over 20 000 deaths, accounting for 4.3% of all deaths in South Africa in 2000, could be attributed to diabetes when excess mortality was taken into account. This places diabetes as the 7th commonest cause of death in this country, which is lower than the 5th place accorded to diabetes in the global study for the same year. In that report, Roglic et al. found that diabetes had a global mortality of 2.9 million deaths and accounted for 5.2% of all deaths. Not surprisingly, the South African estimates from our study fall between the lowest mortality (2.4%) reported for the poorest African and Western Pacific countries, and the highest mortality (~9%) in the Arabian Peninsula, East Mediterranean region, Canada and the USA. Interestingly, the global mortality attributable to HIV/AIDS and diabetes are similar, unlike the situation in South Africa where the former accounted for 6 times more deaths than diabetes in 2000.

Yet our estimates for mortality attributable to diabetes may well be conservatively low. Firstly, they are based on cross-sectional prevalence data obtained 5 - 15 years previously as current diabetes prevalence data were not available. Given global trends, these prevalences are likely to underestimate the prevalences for 2000. Secondly, RRs for IHD, stroke and renal disease from the Asia Pacific region were used because of the absence of available data from Africa. However, the INTERHEART study indicates that the RR for IHD at least may be higher for the black African population. Similarly, it is quite conceivable that the RR for deaths due to renal disease may be higher in South Africa than the Asia Pacific region. Although South Africa has well-developed public and private health sectors, there is strict rationing of renal replacement to the ~80% of the population served by the public sector. In this sector, renal replacement treatment is generally limited to patients under 60 years old who have stable employment and social support. The age cut-off tends to exclude the majority...
### Table III. Burden attributable to diabetes by sex, South Africa, 2000

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Males PAF (%)</th>
<th>Males Deaths</th>
<th>Males DALYs</th>
<th>Females PAF (%)</th>
<th>Females Deaths</th>
<th>Females DALYs</th>
<th>Persons PAF (%)</th>
<th>Persons Deaths</th>
<th>Persons DALYs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischaemic heart disease</td>
<td>13</td>
<td>1 881</td>
<td>21 688</td>
<td>15</td>
<td>1 932</td>
<td>18 310</td>
<td>14</td>
<td>3 813</td>
<td>39 998</td>
</tr>
<tr>
<td>Stroke</td>
<td>8</td>
<td>966</td>
<td>11 289</td>
<td>11</td>
<td>1 839</td>
<td>20 331</td>
<td>10</td>
<td>2 805</td>
<td>31 620</td>
</tr>
<tr>
<td>Hypertensive disease</td>
<td>11</td>
<td>458</td>
<td>5 134</td>
<td>12</td>
<td>1 168</td>
<td>11 027</td>
<td>12</td>
<td>1 627</td>
<td>16 161</td>
</tr>
<tr>
<td>Renal disease*</td>
<td>11</td>
<td>405</td>
<td>3 156</td>
<td>14</td>
<td>596</td>
<td>4 216</td>
<td>12</td>
<td>1 001</td>
<td>7 372</td>
</tr>
<tr>
<td>Type II diabetes†</td>
<td>100</td>
<td>4 610</td>
<td>60 423</td>
<td>100</td>
<td>8 556</td>
<td>102 454</td>
<td>100</td>
<td>13 166</td>
<td>162 877</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>8 321</td>
<td>101 690</td>
<td>14 091</td>
<td>258 028</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

95% uncertainty interval:

- Health outcome: 7.997 - 9.878
- Total: 91 391 - 117 425

% of total:

- Health outcome: 3.0% - 1.2%
- Total: 1.1 - 1.4%

95% uncertainty interval:

- Health outcome: 2.8 - 3.4%
- Total: 1.1 - 1.4%

*Renal disease/failure PAFs applied to nephritis/nephrosis burden (revised South African National Burden of Disease Study 2000). 11
†Type II diabetes PAFs were applied to the total diabetes burden in adults 30 years and older (revised South African National Burden of Disease Study 2000). 11
PAF = population-attributable fraction; DALYs = disability-adjusted life years.

...
challenge in extending these findings to the general population and it would require major partnerships between government, communities, non-governmental organisations (NGOs) and industries, supporting shifts in social policy, such as creating environments conducive to increasing possibilities for safe physical activity and eating healthily. The national Department of Health has already launched the healthy lifestyle programme, but its implementation and uptake are uncertain. In the same vein, the first national guidelines for the management of diabetes at the primary care level were published in 1997, but this did not appear to impact on the quality of care because of problems with implementation. Indeed, sufficient policies for the management and prevention of diabetes and other chronic diseases have been developed at a national level. These however remain to be implemented by the provinces and local authorities. Clearly a new framework is critical to drive the successful implementation of national policies and guidelines. This requires an integrated platform between different levels of government, NGOs and industry to co-ordinate the implementation of these policies. Importantly, measures to evaluate these must also be put in place.

Conclusions and recommendations

In conclusion, the burden due to diabetes is unacceptably high in South Africa. Intensive efforts are required to improve health care delivery such that the proportions of people achieving targets for blood pressure and blood glucose control, as well as receiving appropriate screening for complications with subsequent intervention, can achieve levels that will impact on morbidity and mortality. Colagiuri et al. argue that changes in social policy will be the key to changing the social and physical environment required to achieve widespread reductions in the incidence and prevalence of diabetes.

The launch of the Diabetes Strategy for Africa in December 2006 is timely as it outlines a plan of action and calls on governments, NGOs and industry to implement an integrated and comprehensive approach to reduce the burden of diabetes in the region. It advocates the continuum of interventions from primary prevention right through to palliative care. South Africa is well ahead in the diabetes epidemic but also has many of the resources required to place it at the forefront of implementing the plan of action.

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References


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