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Diabetes Atlas

Mortality attributable to diabetes: Estimates for the year 2010

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ABSTRACT

Country and global health statistics underestimate the number of excess deaths due to diabetes. The aim of the study was to provide a more accurate estimate of the number of deaths attributable to diabetes for the year 2010. A computerized disease model was used to obtain the estimates. The baseline input data included the population structure, estimates of diabetes prevalence, estimates of underlying mortality and estimates of the relative risk of death for people with diabetes compared to people without diabetes.

The total number of excess deaths attributable to diabetes worldwide was estimated to be 3.96 million in the age group 20–79 years, 6.8% of global (all ages) mortality. Diabetes accounted for 6% of deaths in adults in the African Region, to 15.7% in the North American Region. Beyond 49 years of age diabetes constituted a higher proportion of deaths in females than in males in all regions, reaching over 25% in some regions and age groups. Thus, diabetes is a considerable cause of premature mortality, a situation that is likely to worsen, particularly in low and middle income countries as diabetes prevalence increases. Investments in primary and secondary prevention are urgently required to reduce this burden.

Contents

1. Introduction

Mortality is an important measure of population health and is often used to assign priorities in health interventions. Estimating mortality due to diabetes has been challenging because more than a third of countries of the world have no reliable data available on mortality and also because existing routine health statistics have been shown to underestimate

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mortality from diabetes [1]. The latter is largely because persons with diabetes most frequently die of cardiovascular disease or renal failure, rather than a complication specific to diabetes [2]. Cause specific mortality statistics are based on the underlying cause of death recorded on the death certificate. In cases of cardiovascular disease death in particular diabetes is frequently not mentioned at all, or if it is, it is not specified as the underlying cause of death [3]. The problem of assessing the true mortality contribution of a disease is not unique to diabetes. Complex and resource-demanding methods that combine vital registration, results of population-monitoring laboratories and epidemiologic studies, have been developed for estimating mortality attributable to some conditions deemed to be of public health importance (AIDS, tuberculosis), but equivalent methods have not been developed for diabetes [4].

To provide a more realistic estimate of the burden of mortality attributable to diabetes than is available from routine sources of health statistics, a modelling approach has been used recently for the years 2000 and 2007 [5,6]. This study uses similar methodology to estimate the number of deaths attributable to diabetes in the year 2010.

2. Methods

The number of deaths attributable to diabetes was calculated using the following input data:

(1) Expected number of all deaths in the year 2010, applying the age- and sex-specific death rate for the year 2007, as 2007 is the latest year for which WHO life tables are available.
(2) Country-specific diabetes prevalence by age and sex for the year 2010 (see the paper by Shaw et al., also available on this site/CD rom).
(3) Age- and sex-specific relative risks of death for persons with diabetes, compared to their non-diabetic peers in the same population. These were obtained from published studies conducted in USA [7] and Taiwan [8], or as personal communication of non-published data from the DECODE Study that studied European populations and the DECODA Study that studied Asian populations [9,10]. The criteria for the selection of these studies were that they were large population-based cohort studies and that they provided the number of deaths among individuals with and without diabetes by sex and age group.

Table 1 shows the age-specific relative risks of mortality in people with diabetes compared to those without from the different studies. The table also indicates which study results were used for different International Diabetes Federation regions.

DisMod II, a software programme developed for the Global Burden of Disease 2000 Study [11], was used to calculate the number of deaths attributable to diabetes in persons 20–79 years old, i.e. the number of deaths among those with diabetes over and above deaths expected according to underlying mortality rates. DisMod II smoothes out the age-specific relative risks of death available from the different studies and calculates what proportion of all deaths is attributable to diabetes using Miettinen's formula for the population-attributable fraction [12].

Cohort studies estimate the true population relative risk of dying with some uncertainty, and measures of precision, such as confidence intervals, around the estimates were not available for all of the studies used in the calculations of the number of deaths. In order to reflect the uncertainty in the relative risk estimates, sensitivity analyses were conducted assuming that the true relative risks were 20% lower and 20% higher than those found in each cohort study.

3. Results

The numbers of excess deaths due to diabetes are presented by IDF Regions in Table 2. It is predicted that almost 4 million deaths in 2010 could be attributed to diabetes, which is 6.8% of global (all ages) all-cause mortality. In all regions, bar one, roughly 10% or more of deaths in the age group 20–79 were attributable to diabetes, with the highest proportion (15.7%) being in North America, reflecting both a high prevalence of

Table 1 – Age- and sex-specific relative risks of death used to estimate the proportion of all deaths attributable to diabetes.

Age group (years)	DECODE Study[a]		DECODA Study[b] [Indians in Mauritius and Fiji]		DECODA Study[c] [All]		Taiwan Study[d]		NHANES[e]	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
20–29	3.66	6.05	3.40	5.12	3.70	5.95	5.42	4.68	3.08	3.20
30–39	3.38	5.41	3.50	4.98	3.30	5.61	5.26	4.64	4.60	3.10
40–49	1.85	3.14	2.60	3.65	1.95	3.41	4.24	4.25	2.80	2.80
50–59	1.63	2.64	2.30	3.29	1.65	2.73	3.02	3.44	2.00	2.60
60–69	1.60	2.04	1.60	2.51	1.62	2.08	2.22	2.58	1.65	2.10
70–79	1.39	1.79	1.50	2.42	1.40	1.78	1.46	1.61	1.40	1.60

[a] Used for Europe, Australia and New Zealand.
[b] Used for South Asia.
[c] Used for Africa and Eastern Mediterranean.
[d] Used for Western Pacific (except Australia and New Zealand).
[e] Used for North and South America and the Caribbean.

Table 2 – Number of deaths attributable to diabetes in age group 20–79 years in the year 2010.

IDF Region	Number of deaths attributable to diabetes in age group 20–79 years	Percentage of all-cause deaths attributable to diabetes in age group 20–79 years
Africa	332,584	6.0
Eastern Mediterranean and Middle East	294,037	11.5
Europe	634,054	11.0
North America	313,208	15.7
South and Central America	171,303	9.5
South-East Asia	1,142,914	14.3
Western Pacific	1,074,955	9.7

Table 3 – Number of deaths attributable to diabetes if the true relative risk of dying is 20% lower and 20% higher than estimated in the cohort studies.

IDF Region	Relative risk 20% lower	Relative risk 20% higher
Africa	217,914	441,267
Eastern Mediterranean and Middle East	181,898	392,806
Europe	345,126	882,648
North America	186,974	419,104
South and Central America	91,659	239,358
South-East Asia	802,914	1,461,543
Western Pacific	721,358	1,386,849

diabetes and a relatively elderly population. Africa is the region with the lowest proportion of deaths attributable to diabetes in adults. But even here diabetes accounted for over 1 in 20 deaths, representing over a third of a million deaths in 2010.

Table 3 shows the number of deaths attributable to diabetes if the relative risks of dying are assumed to be 20% lower and 20% higher than what was estimated in the cohort studies. With these assumptions the global number of deaths attributable to diabetes ranges from 2.6 to 5.2 million. If the relative risk is 20% lower, 4.5% of total mortality can be attributed to diabetes, ranging from 3.9% in the African Region, to 10.1% in the South-East Asian Region. If the relative risk of dying is 20% higher, 9.2% of total mortality can be attributed to diabetes, ranging from 7.9% in the African Region to 21% in the North American Region.

The highest number of deaths attributable to diabetes is expected to occur in countries with large populations—1,008,000 deaths in India, 575,000 in China, 231,000 in The United States of America and 182,000 in The Russian Federation. The number of deaths is also higher in women than in men, and diabetes makes for a higher proportion of all deaths in women than in men, reaching up to a quarter of all deaths in middle-aged women in some regions (Tables 4a and 4b).

4. Discussion

While there has been a documented decline in the morbidity and mortality of some chronic noncommunicable diseases in some countries [13], no such decline has been reported for diabetes. Wherever measured, the prevalence seems to be increasing. Although some developed countries have documented an improved survival of persons with diabetes, the increased prevalence is most likely due to increased incidence rather than improved survival [14].

Comparing these estimates of mortality attributable to diabetes to those for the year 2007 [6], obtained by using the same relative risks of dying but different diabetes prevalence estimates and all-cause mortality rates, the number of deaths attributable to diabetes has increased by 5.5%. This increase is on account of a 29% increase in the number of deaths due to diabetes in the Northern American Region, a 12% increase in the South-East Asian Region and an 11% increase in the Western Pacific Region. These increases can be explained by an increase in diabetes

Table 4a – Number of male deaths attributable to diabetes in the year 2010 and percentage of all-cause mortality by age group and IDF Region.

IDF Region	Age group (years)					
	20–29	30–39	40–49	50–59	60–69	70–79
Africa	11,141 (3.1)	27,984 (5.3)	21,918 (4.2)	21,405 (4.3)	23,708 (4.9)	16,018 (3.4)
Eastern Mediterranean and Middle East	4,986 (3.4)	12,414 (9.0)	15,874 (9.1)	26,911 (9.6)	33,342 (10.1)	23,516 (6.0)
Europe	5,860 (4.3)	17,216 (8.0)	23,342 (6.0)	52,692 (7.4)	85,933 (10.4)	112,557 (9.0)
North America	2,090 (4.2)	7,104 (11.7)	16,396 (13.9)	30,136 (13.6)	43,555 (14.0)	41,726 (10.6)
South and Central America	1,527 (1.5)	8,584 (8.6)	13,744 (10.6)	19,845 (10.4)	22,520 (8.9)	17,273 (5.5)
South-East Asia	13,908 (3.9)	41,924 (10.0)	70,849 (12.5)	130,209 (14.9)	105,092 (9.6)	114,922 (9.6)
Western Pacific	9,976 (3.6)	33,198 (9.4)	96,470 (14.4)	170,141 (14.4)	180,205 (10.4)	98,276 (4.0)

Table 4b – Number of female deaths attributable to diabetes and its percentage of all-cause mortality by age group and IDF Region.

IDF Region	Age group (years)					
	20–29	30–39	40–49	50–59	60–69	70–79
Africa	25,256 (6.1)	50,422 (9.5)	37,373 (8.7)	35,970 (9.0)	30,895 (7.1)	30,495 (6.0)
Eastern Mediterranean and Middle East	6,021 (6.3)	15,867 (16.2)	23,217 (19.3)	40,942 (22.2)	44,242 (17.7)	46,707 (13.1)
Europe	1,131 (2.8)	4,966 (6.9)	14,706 (9.5)	50,606 (15.0)	76,976 (15.4)	188,069 (16.0)
North America	634 (3.2)	3,634 (11.4)	15,776 (22.2)	41,362 (29.4)	58,544 (25.9)	52,252 (15.1)
South and Central America	456 (1.5)	1,937 (4.6)	7,833 (10.7)	20,638 (17.1)	29,580 (16.6)	27,367 (10.1)
South-East Asia	20,901 (7.1)	42,680 (15.6)	67,618 (19.0)	137,823 (24.0)	168,370 (20.1)	228,618 (20.2)
Western Pacific	3,032 (2.3)	15,742 (7.2)	61,207 (14.3)	127,138 (18.0)	161,150 (15.3)	118,420 (6.2)

prevalence in some highly populated countries in each region (USA, India and Indonesia), particularly in females. In the other regions, the number of deaths attributable to diabetes has remained similar to the estimates for the year 2007.

The consistently higher contribution of diabetes to total mortality in women is partly explained by higher relative risks of mortality in women with diabetes compared to women without diabetes than found in men, in most regions and age groups (Table 1). This in part reflects that overall mortality in men is higher than in women. In addition, in the oldest age group there tend to be more women with diabetes than men, and the numbers of deaths attributable to diabetes in women are therefore higher in most regions (Tables 4a and 4b).

The reliability of these estimates rests on several assumptions, as discussed below.

4.1. *Accuracy of diabetes prevalence estimates*

The prevalence of diabetes by country was used in the calculation of the proportion of deaths attributable to diabetes. There are many countries that have never conducted a survey to determine the prevalence of diabetes. Therefore, many country-specific estimates were calculated by extrapolation of data from countries judged to be ''similar''. This judgment of similarity is not based on strict methodology and thus might not be replicated by other researchers undertaking a similar task.

4.2. *Relative risk of dying*

The number of large, population-based follow-up studies to compare the mortality experience of people with diabetes to those without is very small. Therefore, unpublished data from large studies were also used. It is uncertain whether the relative risks of death observed in the selected studies are appropriate for extrapolation to countries or populations for which there are no data.

Available follow-up studies are consistent in reporting a higher risk of dying for persons with diabetes compared to those without, the relative risk decreasing with age. However, the accuracy of the obtained relative risks of dying is questionable, particularly when data are analysed by age and sex subgroups thus reducing the sample size.

4.3. *All-cause mortality rates*

The expected number of deaths due to all causes was calculated using the mortality rate for the year 2007, as these were available from the World Health Organisation mortality statistics. The assumption that 2007 mortality rates are similar to what they will be in 2010 is probably tenable, as mortality rates are unlikely to substantially change in the short period 2007–2010. However, some countries had a considerable discrepancy between the expected number of all deaths, and consequently diabetes deaths, for the year 2007 and 2010 (Belize, Guyana, Qatar, Rwanda and United Arab Emirates). This indicates that applying a death rate of several years previously to the current population size might not be appropriate for some countries, especially those where the death rate can be considerably different even within short periods.

It is reassuring that a similar result has been obtained in a study where different methods were used to estimate the number of deaths attributable to ''higher-than -optimum blood glucose concentration'' [15], but it is possible that this similarity has occurred by chance.

These estimates exclude the number of deaths attributable to diabetes below the age of 20 and above the age of 79 years because there was very little data on the relative risk of dying in those age groups. Since diabetes is a relatively rare condition below the age of 20, even a high relative risk of dying associated with having diabetes would not substantially change the current estimates. On the other hand, with population ageing and increasing numbers of persons that live beyond the age of 79 years, a substantial number of deaths attributable to diabetes could have been missed if the risk of dying in elderly persons with diabetes was higher than the risk of their non-diabetic peers.

Including people with currently recognized categories of hyperglycaemia other than diabetes would have increased the current estimates of excess deaths attributable to hyperglycaemia because people within the category of impaired glucose tolerance (IGT) have been shown to have higher mortality than people with glycaemia below the cut-off point for IGT [16]. Estimating the burden of excess mortality in this category of hyperglycaemia was not undertaken because of insufficient input data for the model.

Obtaining accurate estimates of mortality attributable to diabetes with currently available data is difficult, and any

attempt will be based on a set of assumptions. The estimates of the number of deaths in this study should be considered just that, estimates and not accurate measures. However, it is highly plausible that the figures presented here are closer to the truth than estimates derived from routine sources of health statistics which systematically underestimate the burden of mortality due to diabetes [17].

The estimated excess number of deaths attributable to diabetes seems to be considerable and of a similar order of magnitude as deaths due to several infectious diseases that receive a lot of attention from policy makers, researchers, donors and the general public [18,19]. Diabetes contributes substantially the world over to premature adult mortality. A substantial proportion of these premature deaths are potentially preventable through public health action directed at primary prevention of diabetes in the population and improvement of care for all people with diabetes [20].

Conflict of interest

The authors state that they have no conflict of interest. The views expressed within this paper are those of the authors and not necessarily those of WHO.

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