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Diabetes Atlas

IDF Diabetes Atlas: Global estimates of the prevalence of diabetes for 2011 and 2030

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ABSTRACT

Introduction: Diabetes is an increasingly important condition globally and robust estimates of its prevalence are required for allocating resources.
Methods: Data sources from 1980 to April 2011 were sought and characterised. The Analytic Hierarchy Process (AHP) was used to select the most appropriate study or studies for each country, and estimates for countries without data were modelled. A logistic regression model was used to generate smoothed age-specific estimates which were applied to UN population estimates for 2011.
Results: A total of 565 data sources were reviewed, of which 170 sources from 110 countries were selected. In 2011 there are 366 million people with diabetes, and this is expected to rise to 552 million by 2030. Most people with diabetes live in low- and middle-income countries, and these countries will also see the greatest increase over the next 19 years.
Discussion: This paper builds on previous IDF estimates and shows that the global diabetes epidemic continues to grow. Recent studies show that previous estimates have been very conservative. The new IDF estimates use a simple and transparent approach and are consistent with recent estimates from the Global Burden of Disease study. IDF estimates will be updated annually.

1. Introduction

Diabetes mellitus is one of the most common chronic diseases in nearly all countries, and continues to increase in numbers and significance, as economic development and urbanization lead to changing lifestyles characterised by reduced physical activity, and increased obesity. Estimates of the current and future burden of diabetes are important in order to allocate community and health resources, to emphasise the role of lifestyle, and encourage measures to counteract trends for increasing prevalence.

There have been several previous estimates of the number of persons with diabetes [1–4] and recently the Global Burden of Disease project published estimates for the years 1980 and 2008 using a complex multi-level approach [5]. The International Diabetes Federation (IDF) has routinely produced estimates of the prevalence of diabetes every 3 years from the year 2000 [6–10] and the estimates produced here update the IDF estimates for 216 countries and territories.

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2. Materials and methods

2.1. Study selection

Full details of the methods and assumptions are given in the accompanying paper by Guariguata and Whiting [11]. Briefly, the PubMed database and Google Scholar were searched for sources published between January 1980 and April 2011, using the search terms: ('diabetes' or 'impaired glucose tolerance') and 'prevalence' and (country name or region/continent); 'cardiovascular risk factors' and (country name or region/continent).

Studies were identified that reported on the prevalence of diabetes for at least three adult age-groups. A number of other avenues were explored in the search for relevant data. Relevant citations from each article were obtained, and diabetes researchers in each IDF geographical region were consulted. Studies were classified by a number of criteria: method of diagnosis; population size; study type (e.g. population-based, clinic-based, diabetes registry, medical records review); representativesness; age of the data source; type of data source (e.g. peer-reviewed publication, national report).

Scores for each criterion were determined by an expert committee using the Analytic Hierarchy Process (AHP) [12] and applied to each potential data source. AHP is a means by which criteria from different domains may be compared, e.g. study size versus age of the study. Two thresholds, lower and upper, were determined. Studies that scored below the lower threshold were discarded and studies that scored above the upper threshold were selected. For each country, where there were no studies above the upper threshold, the top-scoring study between the lower and upper threshold along with any other studies with a score that was within 10 percentage points of the top-scoring study were selected. In countries where more than one study was selected, a weighted average, based on the score, was calculated for each age-specific prevalence.

If no studies were selected for a country, data from countries within a 'data region' were used as a proxy. A data region was defined as a combination of IDF region, World Bank country income group [13] and most common ethnicity.

Estimates were made of the total diabetes population, including those who were newly diagnosed in surveys, and those with type 1 diabetes.

2.2. Statistical methods

For each data source, prevalence was modelled using a logistic regression, with age as a quadratic term to allow flattening for older ages. Rates were calculated separately for males and females, and for urban and rural populations. Where data were not available for one setting or for one sex, these were estimated from prevalence ratios from other sources within the data region. The proportion of people found in population-based prevalence surveys to have undiagnosed diabetes was estimated for each combination of IDF region and World Bank country income group. These proportions were used to adjust estimates from self-report surveys of diabetes.

The smoothed age- and sex-specific prevalences for urban and rural settings were then applied to each national population distribution for the years 2011 and 2030 (using the United Nations Population estimates [14]) to estimate national prevalence and numbers of adults with diabetes. The age-specific prevalences of each country were also applied to the world population distribution to determine age- and sex-adjusted prevalences for each country. Calculations were performed using the R statistical program [15].

Countries were assigned to regions based on the IDF membership regions [Africa (AFR); Middle East and North Africa (MENA); Europe (EUR); North America and Caribbean (NAC); South and Central America (SACA); Southeast Asia (SEA); Western Pacific (WP)]. Countries were also assigned to World Bank income groups: low-income, lower middle-income, upper middle-income and high income [13].

3. Results

A total of 565 data sources were reviewed, of which 170 sources from 110 countries were selected.

The data sources and the results for the 80 most populous countries (those with 2011 adult population of greater than 6.399 million, with a combined 2011 population of 94% of the world adult population) are shown in Tables 1 and 2. There were 70 of the 80 countries that had their own data (98 separate studies). Details of prevalence and case numbers for all 216 countries can be found in the online Appendix at www.idf.org/diabetesatlas.

The highest regional prevalence (Table 3) for 2011 (after age standardization to the world population) was for MENA, followed by the NAC and WP. The AFR region is expected to have the largest proportional increase in adult diabetes numbers by 2030, followed by MENA, though WP will continue to have the world's highest number of adults with diabetes, due primarily to the number of people with diabetes in China. Every region will have an increase in numbers well in excess of adult population growth, and total numbers with diabetes are likely to increase by 50.7% over the 19 years.

The 10 countries by prevalence are dominated by pacific island states and countries in the Middle East (Table 4). Table 5 shows the 10 countries with the largest numbers of people with diabetes. As might be expected, the countries with the largest populations have the highest number of persons with diabetes. Only Pakistan and Nigeria of the world's 10 most populous countries are not among the 10 countries with the highest diabetes numbers (replaced by Mexico and Egypt) for 2011.

The numbers of people with diabetes differ substantially by World Bank country income group. Fig. 1 shows current estimated numbers of people with diabetes by age-group for 2011 and 2030. The rate of the increase in numbers with diabetes is inversely related to current income status, with the greatest increase expected in low-income countries (92%), followed by lower-middle income countries (57%), upper-middle income countries (46%) and finally higher income countries (25%). This compares to adult populations which are expected to increase by 58%, 29%, 19%, and 7% respectively.

The largest increases are expected in the older age groups in low and lower-middle income countries, with numbers more than doubling for the over 60-year age-group. In high-income countries, an increase (42%) is only expected

Table 1 – Data sources for the 80 most populous countries.

	Country	Data sources
AFR	Angola	Angola [16]
	Burkina Faso	Benin [17,18], Comoros [19], Gambia [20], Ghana [21], Guinea [22]
	Cameroon	Cameroon [23]
	Cote d'Ivoire	Angola [16], Cameroon [23]
	Democratic Republic of Congo	Benin [17,18], Comoros [19], Gambia [20], Ghana [21], Guinea [22]
	Ethiopia	Mali [24], Mauritania [25], Niger [26]
	Ghana	Ghana [21]
	Kenya	Kenya [27]
	Madagascar	Malawi [28], Mozambique [29], Zimbabwe [30]
	Malawi	Malawi [28]
	Mali	Mali [24]
	Mozambique	Mozambique [29]
	Niger	Niger [26]
	Nigeria	Angola [16], Cameroon [23]
	South Africa	South Africa [31]
	Uganda	Kenya [27], United Republic of Tanzania [32,33]
	United Republic of Tanzania	United Republic of Tanzania [32,33]
EUR	Azerbaijan	Albania [34]
	Belarus	Bulgaria [35], Poland [36,37], Russian Federation [38], Turkey [39,40]
	Belgium	Belgium [41]
	Czech Republic	Austria [42], Belgium [41], France [43–45], Germany [46–48], Luxembourg [49], Netherlands [50], Switzerland [51], United Kingdom [52–56]
	France	France [43–45]
	Germany	Germany [46–48]
	Greece	Greece [57,58]
	Hungary	Hungary [59,60]
	Italy	Italy [61,62]
	Kazakhstan	Bulgaria [35], Poland [36,37], Russian Federation [38], Turkey [39,40]
	Netherlands	Netherlands [50]
	Poland	Poland [36,37]
	Portugal	Portugal [63]
	Romania	Bulgaria [35], Poland [36,37], Russian Federation [38], Turkey [39,40]
	Russian Federation	Russian Federation [38]
	Serbia	Bulgaria [35], Poland [36,37], Russian Federation [38], Turkey [39,40]
	Spain	Spain [41,64–67]
	Sweden	Sweden [68,69]
	Turkey	Turkey [39,40]
	Ukraine	Albania [34]
	United Kingdom	United Kingdom [52–56]
	Uzbekistan	Uzbekistan [70]
MENA	Afghanistan	Pakistan [71]
	Algeria	Algeria [72]
	Egypt	Egypt [73]
	Iraq	Iraq [74]
	Islamic Republic of Iran	Islamic Republic of Iran [75]
	Morocco	Morocco [76]
	Pakistan	Pakistan [71]
	Saudi Arabia	Saudi Arabia [77–81]
	Sudan	Sudan [82]
	Syrian Arab Republic	Iraq [74], Jordan [83–85], Occupied Palestinian Territory [86,87]
	Tunisia	Tunisia [88]
	Yemen	Iraq [74], Jordan [83–85], Occupied Palestinian Territory [86,87]
NAC	Canada	Canada [89]
	Mexico	Mexico [90]
	United States of America	United States of America [91,92]
SACA	Argentina	Argentina [93]
	Brazil	Brazil [94,95]
	Chile	Chile [96]
	Colombia	Brazil [94,95]
	Cuba	Costa Rica [97], Dominican Republic [98]
	Ecuador	Bolivia [99]
	Guatemala	Guatemala [100]

Table 1 (*Continued*)

	Country	Data sources
	Peru	Argentina [93], Chile [96]
	Venezuela	Brazil [94,95]
	Bangladesh	Bangladesh [101,102]
	India	India [103]
	Nepal	Nepal [104–106]
	Sri Lanka	Sri Lanka [107,108]
WP	Australia	Australia [109,110]
	Cambodia	Cambodia [111]
	China	China [112]
	Democratic People's Republic of Korea	Myanmar [113]
	Indonesia	Indonesia [114]
	Japan	Hong Kong China [115,116], Republic of Korea [117,118], Taiwan [119,120]
	Malaysia	Malaysia [121–123]
	Myanmar	Myanmar [113]
	Philippines	Philippines [124]
	Republic of Korea	Republic of Korea [117,118]
	Taiwan	Taiwan [119,120]
	Thailand	Thailand [125,126]
	Viet Nam	Cambodia [111]

Table 2 – Prevalence of diabetes and estimated diabetes numbers among adults aged 20–79 years for the years 2011 and 2030: 80 most populous countries.

Country	Prevalence (%) adjusted to				Number of adults with diabetes (000s)		Mean annual increment (000s)
	World population		National population				
	2011	2030	2011	2030	2011	2030	
AFR							
Angola	2.9	3.4	2.2	2.4	185	383	10
Burkina Faso	3.0	3.6	2.4	2.7	175	371	10
Cameroon	6.1	7.1	5.2	5.9	501	913	22
Côte d'Ivoire	4.9	6.1	4.2	5.0	406	813	21
Democratic Republic of Congo	3.1	3.7	2.5	2.7	731	1422	36
Ethiopia	3.4	3.7	3.5	3.8	1377	2629	66
Ghana	5.0	6.2	4.1	5.0	517	1036	27
Kenya	5.1	6.3	4.0	5.0	769	1683	48
Madagascar	4.7	5.1	4.4	4.5	428	831	21
Malawi	5.6	6.5	5.4	6.1	352	747	21
Mali	1.9	2.4	1.5	1.8	100	217	6
Mozambique	3.1	3.9	2.7	3.2	295	581	15
Niger	4.2	4.3	4.4	4.7	284	620	18
Nigeria	4.8	6.0	4.0	4.8	3055	6113	161
South Africa	7.0	7.9	6.5	7.2	1947	2548	32
Uganda	2.8	3.5	2.2	2.5	308	690	20
United Republic of Tanzania	2.8	3.8	2.3	3.0	473	1107	33
EUR							
Azerbaijan	2.8	3.2	2.6	3.4	167	260	5
Belarus	8.0	9.3	9.3	11.2	677	745	4
Belgium	4.8	5.7	6.6	7.6	515	604	5
Czech Republic	5.3	6.4	6.9	8.3	557	660	5
France	5.4	6.6	7.3	8.2	3238	3888	34
Germany	5.3	6.5	8.0	9.5	5022	5585	30
Greece	5.1	6.1	7.0	8.3	603	714	6
Hungary	6.0	7.0	7.6	8.4	568	599	2
Italy	5.1	6.4	7.8	9.5	3560	4238	36
Kazakhstan	7.7	9.0	7.5	9.0	801	1128	17
Netherlands	5.2	6.4	7.3	8.8	882	1095	11
Poland	9.0	10.1	10.6	12.2	3057	3410	19

Table 2 (*Continued*)

Country	Prevalence (%) adjusted to						Mean annual increment (000s)
	World population		National population		Number of adults with diabetes (000s)		
	2011	2030	2011	2030	2011	2030	
Portugal	9.5	11.5	12.7	15.2	1021	1201	9
Romania	7.7	9.0	9.2	11.1	1506	1709	11
Russian Federation	9.7	11.5	11.5	13.9	12,593	14,113	80
Serbia	7.7	9.0	9.3	10.5	671	752	4
Spain	6.3	7.8	8.1	10.6	2840	3932	57
Sweden	4.2	5.0	5.7	6.1	386	433	2
Turkey	7.9	9.4	7.4	9.5	3502	5921	127
Ukraine	2.9	3.3	3.5	4.0	1196	1208	1
United Kingdom	5.2	6.2	6.8	7.5	3064	3646	31
Uzbekistan	6.4	7.7	5.0	6.8	813	1547	39
MENA							
Afghanistan	7.6	8.6	6.0	6.2	818	1649	44
Algeria	6.9	7.7	6.3	7.6	1435	2351	48
Egypt	16.6	19.1	15.2	17.8	7323	12,374	266
Iraq	9.1	10.4	7.2	8.0	1089	2334	66
Islamic Republic of Iran	11.1	12.8	9.3	13.1	4695	8384	194
Morocco	6.8	7.9	6.4	7.8	1268	2035	40
Pakistan	7.9	8.9	6.7	7.8	6349	11,408	266
Saudi Arabia	19.6	22.3	16.2	20.8	2760	5462	142
Sudan	8.6	9.8	7.6	8.5	1667	3166	79
Syrian Arab Republic	9.9	11.5	8.2	9.4	890	1707	43
Tunisia	9.5	11.2	8.9	11.8	630	1042	22
Yemen	9.6	11.2	6.7	7.4	727	1569	44
NAC							
Canada	8.4	10.0	10.8	12.8	2716	3672	50
Mexico	15.6	17.6	14.8	17.6	10,294	16,440	323
United States of America	9.3	10.5	10.9	11.8	23,722	29,609	310
SACA							
Argentina	5.5	6.4	5.8	6.5	1532	2078	29
Brazil	10.1	11.9	9.7	12.3	12,440	19,605	377
Chile	9.5	11.1	10.2	12.3	1190	1730	28
Colombia	9.7	11.5	9.1	11.4	2609	4412	95
Cuba	9.4	11.4	11.4	15.3	939	1293	19
Ecuador	6.6	7.8	6.0	7.5	524	890	19
Guatemala	9.3	10.9	7.7	8.4	533	1037	27
Peru	6.0	6.8	5.4	6.4	942	1523	31
Venezuela	10.2	12.0	9.4	11.4	1675	2835	61
SEA							
Bangladesh	10.5	13.7	9.6	13.3	8406	16,837	444
India	9.0	10.6	8.3	9.9	61,258	101,203	2102
Nepal	3.6	5.4	3.0	4.5	488	1171	36
Sri Lanka	7.5	8.7	7.8	9.1	1080	1467	20
WP							
Australia	6.6	7.9	8.1	9.3	1292	1781	26
Cambodia	2.9	3.5	2.5	3.1	199	363	9
China	8.8	10.5	9.3	12.1	90,045	129,695	2087
Democratic People's Republic of Korea	8.4	9.7	9.1	10.3	1508	1934	22
Indonesia	5.1	5.9	4.7	5.9	7292	11,802	237
Japan	7.7	8.9	11.2	12.0	10,674	10,152	27
Malaysia	12.1	13.7	11.7	13.3	2030	3297	67
Myanmar	7.1	8.6	6.7	8.9	2104	3482	73
Philippines	9.7	11.4	8.2	9.6	4220	7430	169
Republic of Korea	7.5	8.7	8.8	11.1	3186	4251	56
Taiwan	8.3	8.6	9.6	11.1	1665	2010	18
Thailand	7.5	8.7	8.2	9.8	4014	5454	76
Viet Nam	3.2	3.9	2.9	4.2	1703	3116	74

Table 3 – Prevalence of diabetes and estimated diabetes numbers by region among adults aged 20–79 years for the years 2011 and 2030.

	2011			2030			
	Population (000s)	Cases (000s)	Adjusted prevalence (%)[a]	Population (000s)	Cases (000s)	Adjusted prevalence (%)[a]	Increase
AFR	387	14.7	5	658	28	5.9	90.5
EUR	651	52.6	6	671	64	7.1	21.7
MENA	359	32.8	12.5	542	60	14.3	82.9
NAC	322	37.7	11.1	386	51.2	12.6	35.8
SACA	290	25.1	8.6	376	39.9	10.1	59
SEA	856	71.4	8.6	1188	120.9	10.5	69.3
WP	1544	131.9	10.1	1766	187.9	11.6	42.5
World	4409	366.2	8.3	5587	551.9	9.9	185.7

[a] Age-standardized to the world population.

Table 4 – Top 10 countries for diabetes prevalence in 2011 and 2030.

2011			2030		
Country	Crude prevalence	Adjusted prevalence	Country	Crude prevalence	Adjusted prevalence
Kiribati	24.9	25.3	Kiribati	27.7	28.3
Marshall Islands	21.5	21.8	Marshall Islands	24.2	24.7
Kuwait	15.9	20.7	Lebanon	24.2	23.4
Nauru	20.1	20.4	Kuwait	22.2	23.1
Qatar	14.1	19.8	Tuvalu	21.4	22.5
Saudi Arabia	16.2	19.6	Saudi Arabia	20.8	22.3
Lebanon	18.9	19.6	Qatar	20.9	22.3
Bahrain	15.3	19.5	Nauru	21.7	22.2
Tuvalu	18.7	19.2	Bahrain	24.6	22
United Arab Emirates	12.6	18.8	United Arab Emirates	23.8	21.6

Table 5 – Top 10 countries for numbers of people aged 20–79 years with diabetes in 2011 and 2030.

2011		2030	
Country	Millions	Country	Millions
China	90.0	China	129.7
India	61.3	India	101.2
United States of America	23.7	United States of America	29.6
Russian Federation	12.6	Brazil	19.6
Brazil	12.4	Bangladesh	16.8
Japan	10.7	Mexico	16.4
Mexico	10.3	Russian Federation	14.1
Bangladesh	8.4	Egypt	12.4
Egypt	7.3	Indonesia	11.8
Indonesia	7.3	Pakistan	11.4

among the over 60s, with almost no change predicted for the younger age-groups. Currently, the greatest number of people worldwide with diabetes is in the 40–59-year-old age-group, and this is predicted to remain so in 2030, although there will almost as many people with diabetes in the 60–79-year-old age-group.

The overall total predicted increase in numbers with diabetes from 2011 to 2030 is 50.7%, at an averaged annual growth of 2.7%, which is 1.7 times the annual growth of the total world adult population.

Forty-eight percent of the anticipated absolute global increase of 186 million people with diabetes is projected to occur in India and China alone.

4. Discussion

The estimates presented here are based on methods that are an evolution of the methods developed by Shaw et al. [10] and suggest that in 2011 there will be 366 million people worldwide with diabetes, with considerable disparity between populations and regions. The pattern of diabetes varies considerably according to countries' income status. For countries classified by the World Bank as being high-income countries, most people with diabetes are aged over 60 years, whereas for low- and middle-income countries most people with diabetes are of working age, between 40 and 60 years.

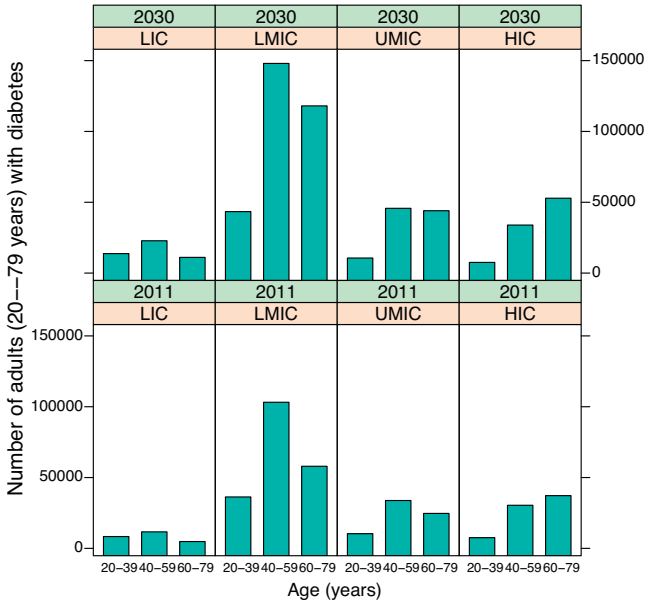

Fig. 1 – Numbers of adults with diabetes by World Bank income group in 2011 and 2030, according to age. LIC: low-income countries; LMIC: lower middle-income countries; UMIC: upper middle-income countries; HIC: high-income countries.

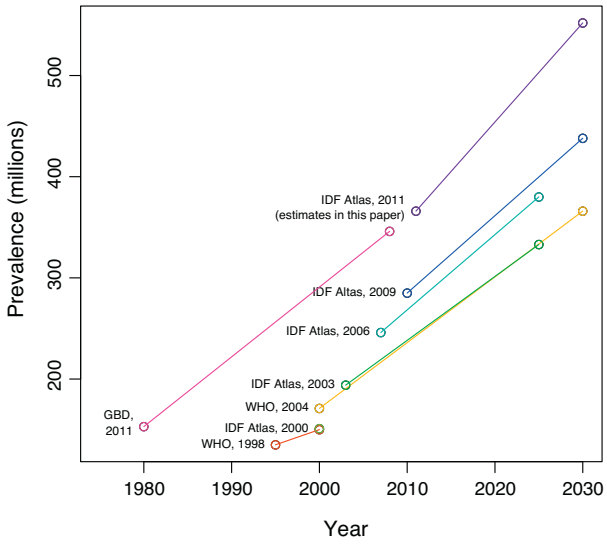

Fig. 2 – Estimates and projections of global diabetes prevalence, including the estimates presented in this paper.

This difference is likely to still be present in 2030, although less marked, as the average age of low- and middle-income countries' populations will increase slightly more than in high-income countries. Population growth, ageing of populations, and urbanization with associated lifestyle change is likely to lead to a 50.7% increase in worldwide numbers with diabetes by 2030.

Over the last 15 years several global estimates of the prevalence of diabetes have been produced, and these are presented in Fig. 2. In 1998, King et al. [3] estimated that there would be 300 million adults with diabetes in 2025; in 2004 WHO estimated 171 million for 2000 and 366 million by 2030 [4]; and previous editions of the IDF Diabetes Atlas have estimated the global prevalence to be 151 million (in 2000) [6], 194 (in 2003) [7], 246 (in 2006) [8], and 285 million (in 2010) [9]. Each estimate has been based on the latest data available and each subsequent estimate has been higher than the previous report. While there were some differences in the methods the main reason for the increase has been the availability of newer data that incorporate real increases in the incidence of diabetes that go beyond what is predicted by the models.

Recently the Global Burden of Disease (GBD) project published estimates of mean glucose levels using a complex multi-level approach [5]. Their estimate of the global prevalence of diabetes, 346 (302–394) million in 2008, is very similar to our estimate, with ours being well-within their uncertainty intervals. The similarity in the global estimate does, however, mask some differences at the country-level, with GBD estimates for countries in Africa appearing to be rather high, and some trends far from intuitive. For example, the GBD project estimates that the prevalence of diabetes in Tanzania in the 1980s, when most of the population living as subsistence farmers and the country was in the middle of a long period of severe economic difficulty, was almost as high as it is now in the USA.

Counter-intuitive country-level estimates notwithstanding, the latest GBD and IDF global estimates are very close to each other, with the IDF estimates continuing the trend in the GBD estimates.

These data suggest that the prevalence of diabetes is increasing, as a consequence of increasing incidence due to demographic changes such as ageing, and as a result of risk factors such as obesity and sedentary life becoming more common, and also a result of better health care improving longevity of people with diabetes. They also indicate that previous modelled estimates have generally been underestimating the prevalence for any given year.

The IDF approach is deliberately simple and conservative. We do not model changes in incidence, and have based our projections for 2030 on predicted demographic changes: urbanization and ageing. Urbanization is associated with a more sedentary lifestyle tending to increase diabetes prevalence [127], so to some extent is a proxy for lifestyle changes. Other than the impact of urbanization, we have not attempted to directly account for the effects of changes in risk factors (e.g. obesity), as accurately assessing the relationship between risk factors and diabetes is difficult across the diverse global population. Thus, if the prevalence of obesity and other risk factors continue to rise, it is likely that the estimates presented here will be lower than the actual prevalence in 2030.

Three major factors affect the accuracy of these estimates: the availability and quality of data, and the representativeness of the data sources chosen. Recently there have been a number of data sources that provide information on diabetes prevalence with 117 out of the 170 studies being multi-regional, population-based studies (although only 41 have used OGTT).

The region with the fewest multi-region population-based data sources is South and Central America, with just 6, of

which only 1 used OGTT. Europe, Western Pacific, Middle East and North Africa had the most multi-region, population-based data sources with 29, 26 and 24, respectively.

The global pattern is dominated by countries with large populations, and these data highlight the extent to which demographic changes in India, China and Brazil are likely to affect the total numbers with diabetes in the future. Each of these countries has had relatively recent national surveys, so that the likelihood of unrepresentative data is reduced.

In summary, these results update the global estimates of diabetes prevalence and show that diabetes is continuing to be an increasing international health burden. The estimates here are higher than previous estimates, and are consistent with recent estimates using more complex methods. The estimates have been generated using a conservative approach and as a result may be an under-estimate.

Ageing and the changes that are associated with urbanization, globalisation and development are increasingly adding to the burden of diabetes in all countries, and particularly in low- and middle-income countries where resources for dealing with the associated clinical problems are most scarce.

Conflict of interest

There are no conflicts of interest.

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