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International Diabetes Federation

IDF Diabetes Atlas

Global estimates of diabetes prevalence for 2013 and projections for 2035

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ABSTRACT

Introduction: Diabetes is a serious and increasing global health burden and estimates of prevalence are essential for appropriate allocation of resources and monitoring of trends.
Methods: We conducted a literature search of studies reporting the age-specific prevalence for diabetes and used the Analytic Hierarchy Process to systematically select studies to generate estimates for 219 countries and territories. Estimates for countries without available source data were modelled from pooled estimates of countries that were similar in regard to geography, ethnicity, and economic development. Logistic regression was applied to generate smoothed age-specific prevalence estimates for adults 20–79 years which were then applied to population estimates for 2013 and 2035.
Results: A total of 744 data sources were considered and 174 included, representing 130 countries. In 2013, 382 million people had diabetes; this number is expected to rise to 592 million by 2035. Most people with diabetes live in low- and middle-income countries and these will experience the greatest increase in cases of diabetes over the next 22 years.
Conclusion: The new estimates of diabetes in adults confirm the large burden of diabetes, especially in developing countries. Estimates will be updated annually including the most recent, high-quality data available.

1. Introduction

Diabetes is one of the most common metabolic disorders in the world and the prevalence of diabetes in adults has been increasing in the last decades [1,2]. Urbanisation has driven dramatic changes in lifestyle and in particular in developing countries. With these rapid transitions come accompanying increases in risk factors for noncommunicable diseases like type 2 diabetes. Estimates of the current and future burden of diabetes are important to appropriately allocate resources, drive health-promoting policies, and encourage action to prevent diabetes in future generations.

The International Diabetes Federation (IDF) has produced estimates of diabetes prevalence since the year 2000 [3–7]. Previous estimates of the prevalence of diabetes have demonstrated a large and increasing burden, with significant regional variability. The estimates in this paper provide the latest figures based on the most recent and highest quality data on diabetes prevalence for 219 countries and territories.

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2. Methods

The methodology applied to generate the estimates is based largely on that used for previous estimates and is described in detail in Guariguata et al. [8]. Briefly, a literature search of PubMed, Medline, and Google Scholar for data sources reporting the age-specific prevalence of diabetes conducted from January 1980 through April 2013 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'. In addition, data sources were gathered from national health surveys conducted by governments, or non-governmental organisations such as the World Health Organization or World Health Surveys. Relevant citations from published literature were also reviewed and investigators within the IDF network were consulted to identify data sources.

Studies were considered for inclusion that reported age-specific prevalence of diabetes for at least three age-groups for adults between 20 and 79 years. Methodological information from studies was abstracted and classified by the following: method of diagnosis; sample size; study type (e.g. population-based, clinic-based, diabetes registry, medical records review); representation (e.g. nationally representative, regionally representative, single city or village, single ethnic group or cohort); age of the data source; type of publication (e.g. peer-reviewed publication, national report).

Using the classification criteria described above, a scoring system was developed using the Analytic Hierarchy Process [9] which allows the comparison of different parameters (e.g. study type versus type of publication) to create a system of weights whereby each criterion for characterisation receives a corresponding score. Experts from the IDF network were asked to complete pairwise comparisons of criteria and a composite score based on the collective opinion was derived. Additional experts were consulted in 2013, producing an updated composite score. The updated scores are available in the online appendix.

The scores for the criteria characterising each element in each study were summed to obtain an overall study score which was used in the selection process. Scores were plotted and produced a bimodal distribution with a smaller cluster at high scores (those scoring 0.5 and above), and a second large cluster ranging from 0.2 to 0.5. The median score was 0.32. Thresholds were selected based on the overall distribution of the scores with one top threshold in the nadir of the first cluster and a bottom threshold at the median. Studies that scored above an upper threshold (0.5) were always selected and those that scored below a lower threshold (0.32) were excluded. Studies scoring between 0.32 and 0.5 were considered for selection if no studies scoring above 0.5 were available from the same country. If considered, the top-scoring study in this middle range and any study scoring within 0.06 of the top-scoring study were selected. In countries where more than one study was selected, the age-specific prevalence of diabetes was calculated using a weighted average taking into account the underlying study scores for that country. Studies which scored most highly were nationally representative, conducted in the last 5 years, based on OGTT, and published in peer-reviewed literature.

When no studies were available for a country, studies from countries matched for geographic region, income group, ethnicity, and IDF Region were aggregated. The groupings used for these extrapolated estimates are available in the online appendix.

Studies were excluded that did not contain sufficient methodological information for characterisation, did not provide enough data on age-specific prevalence of diabetes, were conducted in hospital or clinic-based settings, were based only on treated diabetes, or were conducted before 1980. In addition, duplicates were removed where multiple publications were referencing the same study population or where an update of a survey was conducted using the same sampling frame (e.g. repeated national health surveys), previous ones were excluded. Studies reporting only on type 1 diabetes, or newly diagnosed diabetes were excluded.

2.1. *Statistical methods*

Statistical programming was done using the R statistical program version 2.15.2 [10]. The age- and sex-specific prevalence of diabetes was calculated for urban and rural settings for each country using logistic regression with diabetes prevalence as the dependent variable and age and a quadratic term for age as the independent variables. Where data were not available stratified by urban and rural setting, a ratio was applied to estimate the proportion of diabetes for each setting derived from aggregated data available within a data region together with the percentage urbanisation by country available from the UN Population Division to estimate the proportion of diabetes in urban and rural settings. Where sex-specific data were not available in the study, the distribution of diabetes in males and females was assumed to be the same. If a study was based only on self-reported diabetes, an estimate of undiagnosed diabetes was derived from proportions reported in population-based studies in the same data region. Full details of the methods and results on estimates of undiagnosed diabetes are available from Beagley et al. [11].

The calculated age-, sex- and setting-specific estimates were then multiplied by corresponding estimates of population for 2013 and 2035 for each of 219 countries and territories to produce cases of diabetes in adults. Prevalence estimates were standardised using the WHO Standard Population [12].

The number of people with diabetes for each of the seven IDF Regions (Africa (AFR); Europe (EUR); Middle East and North Africa (MENA); North America and Caribbean (NAC); South and Central America (SACA); South-East Asia (SEA); and the Western Pacific (WP)) and World Bank income group (low-income (LIC); lower middle-income (LMIC); upper middle-income (UMIC); and high-income (HIC)) were calculated by aggregating the numbers of people with diabetes for each country within the respective regions. Global estimates were calculated by aggregating the total cases of diabetes.

3. Results

From the literature search, 744 data sources were identified representing 162 countries. Of these, 174 were selected

Table 1 – Prevalence of diabetes and estimated number of people with diabetes (20–79 years) for 2013 and 2035: 80 most populous countries.

Country/territory	Prevalence adjusted to the national population (%)		Prevalence adjusted to the world population[a] (%)		Diabetes cases (20–79) in 1000s		Mean annual increment (000s)	Proportional change in adult population from 2013 to 2035 (%)	Proportional change in number of people with diabetes from 2013 to 2035 (%)
	2013	2035	2013	2035	2013	2035			
AFR									
Angola	2.2	2.4	2.9	3.1	199	458	12	112.6	130.5
Burkina Faso	3.2	3.4	3.8	3.8	238	505	12	104.7	112.3
Cameroon	4.9	5.6	5.9	6.4	498	1082	27	89.7	117.3
Cote d'Ivoire	5.2	5.7	6.0	6.4	502	965	21	74.2	92.5
Democratic Republic of the Congo	5.4	6.2	6.1	6.9	1594	3601	91	95.2	125.9
Ethiopia	4.4	5.1	4.9	5.5	1852	4418	117	103.5	138.5
Ghana	3.4	3.7	3.8	3.9	440	819	17	70.2	86.1
Kenya	3.6	4.4	4.6	4.9	749	1746	45	91.1	133.0
Madagascar	3.3	3.5	3.8	3.8	352	739	18	101.1	109.8
Malawi	5.3	5.6	5.5	5.8	372	802	20	103.7	115.3
Mozambique	2.5	2.8	2.8	3.2	278	588	14	88.0	111.3
Niger	4.3	4.7	4.2	4.4	306	782	22	136.9	155.3
Nigeria	5.0	5.5	5.8	6.3	3922	8160	193	89.8	108.1
South Africa	8.3	9.9	9.3	9.9	2646	3860	55	22.4	45.9
Tanzania (United Republic of)	7.8	8.6	9.0	9.7	1707	3815	96	102.9	123.5
Uganda	4.1	4.9	4.8	5.6	625	1668	47	126.5	166.9
Zimbabwe	8.8	9.9	9.7	10.4	601	1256	30	86.0	109.1
EUR									
Belarus	6.3	7.4	5.1	5.1	445	460	1	−13.1	3.4
Belgium	6.4	7.3	4.8	4.8	515	604	4	3.6	17.2
Czech Republic	9.2	10.8	6.9	7.0	756	872	5	−1.4	15.4
France	7.5	8.2	5.4	5.5	3375	3961	27	7.1	17.4
Germany	11.9	14.1	8.3	8.3	7560	8109	25	−9.3	7.3
Greece	7.0	8.6	4.8	4.9	585	695	5	−3.4	18.8
Hungary	7.6	8.5	6.0	6.1	573	591	1	−8.1	3.1
Italy	7.9	9.8	5.1	5.2	3626	4354	33	−2.9	20.1
Kazakhstan	4.9	5.8	5.0	5.0	526	754	10	19.9	43.4
Netherlands	7.5	9.0	5.2	5.3	914	1101	8	0.2	20.4
Poland	6.5	7.9	5.2	5.2	1880	2133	12	−6.8	13.5
Portugal	13.0	15.8	9.6	9.8	1032	1233	9	−2.0	19.5
Romania	5.1	6.4	4.0	4.0	851	960	5	−9.9	12.8
Russian Federation	10.0	11.6	8.3	8.3	10,924	11,195	12	−11.3	2.5
Serbia	12.4	14.7	9.9	10.2	872	923	2	−11.2	5.8
Spain	10.8	14.4	8.2	8.3	3791	5179	63	2.8	36.6
Sweden	6.4	6.6	4.7	4.7	439	498	3	8.7	13.5
Turkey	14.6	18.5	14.9	15.1	7043	11,786	216	32.3	67.3
Ukraine	3.0	3.4	2.5	2.5	1044	969	−3	−17.6	−7.2
United Kingdom	6.6	7.4	4.9	5.0	2975	3619	29	8.5	21.7
Uzbekistan	5.0	7.1	6.4	6.5	881	1734	39	39.1	96.9
MENA									
Afghanistan	6.3	6.6	8.3	8.5	795	1842	48	120.0	131.8
Algeria	6.6	8.4	7.5	7.8	1640	2889	57	38.8	76.2
Egypt	15.6	18.6	16.8	17.7	7511	13,073	253	46.0	74.1
Iran (Islamic Republic of)	8.4	12.3	9.9	10.1	4396	8396	182	30.5	91.0
Iraq	7.4	8.8	9.5	9.7	1226	2804	72	94.5	128.7
Morocco	7.3	9.2	7.8	8.2	1491	2508	46	33.9	68.2
Pakistan	6.8	8.1	7.9	8.1	6713	12,798	277	59.4	90.7
Saudi Arabia	20.2	27.1	23.9	24.5	3651	7499	175	53.4	105.4
Sudan	7.7	8.7	9.6	9.8	1402	2904	68	85.1	107.1
Syrian Arab Republic	7.4	9.2	8.9	9.1	869	1902	47	75.0	118.9
Tunisia	9.2	12.2	9.4	9.8	686	1130	20	24.5	64.8
United Arab Emirates	10.0	23.1	19.0	19.4	746	2575	83	49.8	245.3
Yemen	6.1	7.5	8.5	8.7	708	1633	42	88.7	130.6

Table 1 (*Continued*)

Country/territory	Prevalence adjusted to the national population (%)		Prevalence adjusted to the world population[a] (%)		Diabetes cases (20–79) in 1000s		Mean annual increment (000s)	Proportional change in adult population from 2013 to 2035 (%)	Proportional change in number of people with diabetes from 2013 to 2035 (%)
	2013	2035	2013	2035	2013	2035			
NAC									
Canada	10.2	11.7	7.9	7.9	2638	3463	37	14.3	31.3
Mexico	11.8	15.2	12.6	12.6	8723	15,684	316	39.4	79.8
United States of America	10.9	11.6	9.2	9.2	24,402	29,718	242	14.8	21.8
SACA									
Argentina	6.0	6.7	5.7	5.7	1608	2223	28	23.3	38.2
Brazil	9.0	11.7	9.2	9.2	11,934	19,223	331	24.4	61.1
Chile	10.4	12.7	9.5	9.5	1254	1841	27	20.1	46.8
Colombia	7.1	8.2	7.3	7.3	2135	3340	55	36.2	56.4
Cuba	9.7	12.7	8.1	8.1	814	1022	9	−3.7	25.5
Ecuador	5.7	6.2	5.9	5.9	530	850	15	46.8	60.4
Guatemala	9.0	9.8	10.9	10.9	661	1376	32	90.6	108.1
Peru	4.3	4.9	4.5	4.5	786	1280	22	40.9	62.8
Venezuela (Bolivarian Rep. of)	6.6	7.8	7.0	7.0	1232	2068	38	41.5	67.9
SEA									
Bangladesh	5.5	8.2	6.3	7.5	5089	10,916	265	44.7	114.5
India	8.6	10.5	9.1	9.7	65,076	109,028	1998	37.0	67.5
Nepal	4.5	5.4	4.9	5.3	674	1253	26	54.2	85.8
Sri Lanka	8.0	9.5	7.6	8.2	1128	1553	19	16.9	37.7
WP									
Australia	10.0	11.3	7.8	7.8	1649	2312	30	24.1	40.2
Cambodia	2.5	3.4	3.0	3.2	221	445	10	48.7	101.1
China	9.6	13.0	9.0	9.5	98,407	142,663	2012	7.3	45.0
Democratic People's Republic of Korea	7.3	8.8	6.7	7.0	1252	1732	22	13.6	38.4
Indonesia	5.6	6.7	5.8	5.9	8554	14,152	254	37.8	65.4
Japan	7.6	8.2	5.1	5.2	7204	6722	−22	−14.2	−6.7
Malaysia	10.1	12.2	10.9	10.9	1913	3299	63	42.8	72.4
Myanmar	5.7	8.0	6.1	6.9	1989	3438	66	23.6	72.9
Philippines	6.0	7.1	6.9	7.2	3256	6014	125	56.3	84.7
Republic of Korea	8.9	11.4	7.5	7.5	3324	4511	54	5.6	35.7
Taiwan	9.8	13.1	8.3	8.3	1721	2299	26	−0.3	33.6
Thailand	6.4	8.3	5.7	5.7	3151	4287	52	4.8	36.1
Viet Nam	5.4	8.2	5.8	6.7	3299	6338	138	25.2	92.1

[a] Adjusted to the WHO Standard 2001 [12].

representing 130 countries. These data produced an estimate of 381.8 million adults in 219 countries and territories with diabetes for 2013; and projected the number to rise to 591.9 million in 2035. The estimates derived from these sources for the 80 most populous countries (with adult populations greater than 6.5 million) are presented in Table 1 and the underlying data sources are presented in Table 2. Sixteen country estimates presented in the table were based on extrapolation. Detailed estimates of prevalence and numbers of people with diabetes on all 219 countries and territories are presented in the online appendix.

There were regional differences in the prevalence of diabetes across the seven IDF Regions and by income group (Table 3 and Fig. 1). The highest regional, unadjusted, prevalence was in the North America and Caribbean region (11.0%). However, after age-adjustment the Middle East and North Africa region had the highest prevalence at 10.9%. While the Africa region has the lowest prevalence of adults with diabetes (5.7%), it is projected to have the largest proportional increase in the numbers of adults with diabetes by 2035, with an increase of 109%. All regions are projected to have an increase in the numbers of people with diabetes larger than those projected for growth in the adult population alone. Overall, the numbers of adults with diabetes will increase by 55% by 2035.

The top ten highest prevalence countries are predominantly Pacific island nations led by Tokelau (Table 4). The other three countries are from the Middle East and North Africa Region: Saudi Arabia, Kuwait, and Qatar. Indeed, many of the countries in the Middle East and North Africa Region have high prevalence rates, well above the global prevalence of 8.3%. In addition, many island nations in the Caribbean, Indian Ocean, and Western Pacific have higher prevalence rates than mainland countries in the same regions.

Countries with large adult populations are also those with high numbers of people with diabetes. China has the highest number of people with diabetes with over 98.4 million adults affected; this is followed closely by India with 65.1 million.

Table 2 – Data sources for estimates of diabetes prevalence for the 80 most populous countries.

IDF Region	Country	Data source(s)
Africa (AFR)		
	Angola	Evaristo-Neto et al. [13]
	Burkina Faso	Gambia [14], Malawi [15], Benin [16,17], Mozambique [18], Togo [19], Zimbabwe [20], Guinea [21]
	Cameroon	CamBoD Project [22]
	Côte d'Ivoire	Cameroon [22]
	Democratic Republic of the Congo	Kenya [23], Niger [24], Mauritania [25], Tanzania [26], Comoros [27], Mali [28]
	Ethiopia	Kenya [23], Niger [24], Mauritania [25], Tanzania [26], Comoros [27], Mali [28]
	Ghana	Gambia [14], Malawi [15], Benin [16,17], Mozambique [18], Togo [19], Zimbabwe [20], Guinea [21]
	Kenya	Christensen et al. [23]
	Madagascar	Gambia [14], Malawi [15], Benin [16,17], Mozambique [18], Togo [19], Zimbabwe [20], Guinea [21]
	Mozambique	Silva-Matos et al. [18]
	Niger	Niger STEPs survey [24]
	Nigeria	Cameroon [22]
	South Africa	Motala et al. [29], Peer et al. [30]
	Uganda	Kenya [23], Niger [24], Mauritania [25], Tanzania [26], Comoros [27], Mali [28]
	Tanzania (United Republic of)	Tanzania STEPs survey [26]
	Zimbabwe	Zimbabwe STEPs survey [20]
Europe (EUR)		
	Belarus	Lithuania [31], Poland [32], Russian Federation, [33], Latvia [34]
	Belgium	van der Heyden et al. [35]
	Czech Republic	Czech Republic Health Survey [36]
	France	Bonaldi et al. [37], Bringer et al. [38], Gourdy et al. [39]
	Germany	Heidemann et al. [40]
	Greece	Tentolouris et al. [41]
	Hungary	Jermendy et al. [42], Vamos et al. [43]
	Italy	Cricelli et al. [44], Italian health survey [45]
	Netherlands	Netherlands Health Interview Survey [46]
	Poland	Polakowska and Piotrowski [33]
	Portugal	Gardete-Correia et al. [47]
	Romania	Romanian Health Interview Survey [48]
	Russian Federation	Dogadin et al. [33]
	Serbia	Romania [48], Bulgaria [49,50], Turkey [51]
	Spain	Soriguer et al. [52]
	Sweden	Sweden Living Conditions Survey [53]
	Turkey	Satman et al. [51]
	Ukraine	Albania [54]
	United Kingdom	Imkampe and Gulliford [55], Health Survey for England [56], Pierce et al. [57]
	Uzbekistan	King et al. [58]
Middle East and North Africa (MENA)		
	Afghanistan	Palestine [59,60], Iraq [61,62], Jordan [63–66], Pakistan [67]
	Algeria	Malek et al. [68], Algeria STEPs Survey [69]
	Egypt	Egypt STEPs survey [70]
	Iraq	Iraq Family Health Survey 2006/7 [61], Iraq STEPs survey [62]
	Islamic Republic of Iran	Esteghamati et al. [71], Iran STEPs survey [72]
	Morocco	Tazi et al. [73]
	Pakistan	Shera et al. [67]
	Saudi Arabia	Al-Daghri et al. [74], Al-Nozha et al. [75], Warsy and El-Hazmi[76], Al-Nuaim [77], Saudi Arabia STEPs Survey [78]
	Sudan	Tunisia [79], Morocco [73], Egypt [70]
	Syrian Arab Republic	Palestine [59,60], Iraq [61,62], Jordan [63–66], Pakistan [67]
	Tunisia	Bouguerra et al. [79]
	United Arab Emirates	Malik et al. [80]
	Yemen	Palestine [59,60], Iraq [61,62], Jordan [63–66], Pakistan [67]
North America and Caribbean (NAC)		
	Canada	National Diabetes Surveillance System [81]
	Mexico	ENSANUT 2012 [82]
	United States of America	NHANES 2012 [83]

Table 2 (*Continued*)

IDF Region	Country	Data source(s)
South and Central America (SACA)		
	Argentina	de Sereday et al. [84], Escobedo et al. [85]
	Brazil	Iser et al. [86]
	Chile	Encuesta Nacional de Salud 2009–2011 [87]
	Colombia	Colombia STEPs survey – Santander [88]
	Cuba	Dominican Republic [89], Colombia [88], Brazil [86], Costa Rica [90,91], Venezuela [85]
	Ecuador	Escobedo et al. [85]
	Guatemala	CAMDi Guatemala [90]
	Peru	Escobedo et al. [85]
	Venezuela	Escobedo et al. [85]
South-East Asia (SEA)		
	Bangladesh	Bangladesh STEPs Survey [92]
	India	Anjana et al. [93]
	Nepal	Mehta et al. [94], Ono et al. [95], Singh and Bhattarai [96]
	Sri Lanka	Katulanda et al. [97], Wijewardene et al. [98]
Western Pacific (WP)		
	Australia	Australia Health Survey 2011 [99]
	Cambodia	Cambodia STEPs Survey [100]
	China	Li et al. [101], Yang et al. [102]
	Democratic People's Republic of Korea	Cambodia [100], Viet Nam [103], Myanmar [104]
	Indonesia	Mihardja et al. [105]
	Japan	Japan National Health Survey [106]
	Malaysia	Letchuman et al. [107], Malaysia STEPs survey [108], Rampal et al. [109]
	Myanmar	Ko-Ko-Zaw et al. [104]
	Philippines	Sy et al. [110]
	Republic of Korea	Choi et al. [111], Kim et al. [112]
	Taiwan	Chang et al. [113]
	Viet Nam	Nguyen et al. [103]

Eight out of the ten most populous countries in the world are also found in the top ten countries with the highest number of adults with diabetes. Only Bangladesh and Nigeria are not in the top ten countries with the highest numbers of people with diabetes (replaced by Mexico and Germany) although these countries are ranked 14 and 16, respectively.

Diabetes prevalence and numbers of people with diabetes vary substantially by World Bank income group. The vast majority of people with diabetes live in low- and middle-income countries. When seen across income groups, the greatest increases in people with diabetes over the next 20 years will parallel increases in the adult population. However,

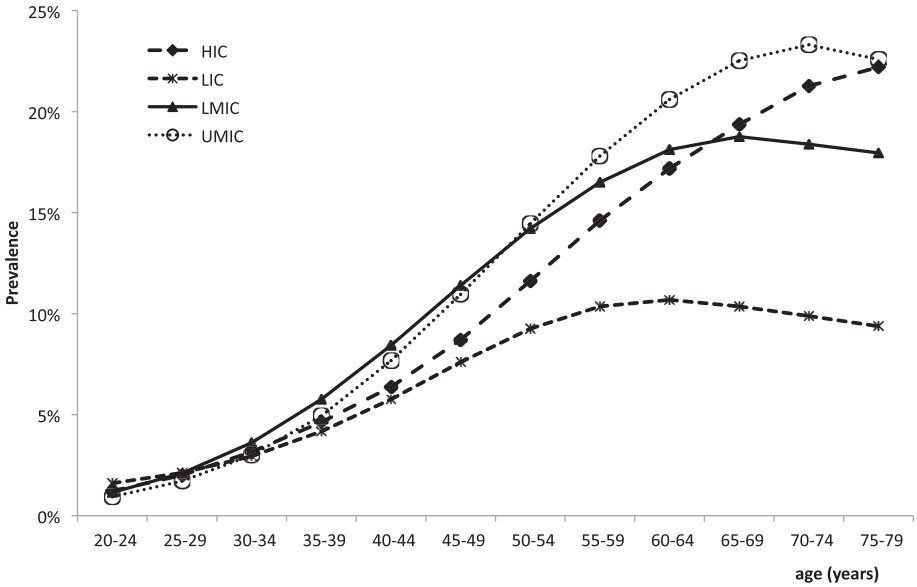

Fig. 1 – Prevalence estimates of diabetes (20–79 years) by income group and age, 2013

Table 3 – Diabetes prevalence and number of people with diabetes (20–79 years) by IDF Region for 2013 and 2035.

Region	2013			2035			
	Population (20–79 years)	Number of people with diabetes (20–79 years)	Comparative diabetes prevalence (20–79 years)	Population (20–79 years)	Number of people with diabetes (20–79 years)	Comparative diabetes prevalence (20–79 years)	Increase in the number of people with diabetes
	Millions	Millions	%	Millions	Millions	%	%
AFR	407.8	19.8	5.7	775.5	41.4	6.0	109.1
EUR	658.7	56.3	6.8	668.7	68.9	7.1	22.4
MENA	347.5	34.6	10.9	583.7	67.9	11.3	96.2
NAC	334.9	36.7	9.6	404.5	50.4	12.3	37.3
SACA	300.5	24.1	8.2	394.2	38.5	8.2	59.8
SEA	883.2	72.1	8.7	1216.9	123.0	9.4	70.6
WP	1613.2	138.2	8.1	1818.2	201.8	8.4	46.0
World	4572.9	381.8	8.3	5861.7	591.9	8.8	55.0

for every percentage increase in the adult population, the proportional increase in the numbers of people will be greater and especially for developing countries. The greatest proportional increase in the number of adults with diabetes is expected in low-income countries (108%), followed by lower middle-income countries (60%), upper middle-income countries (51%), and finally high-income countries (28%).

Diabetes prevalence increases with age across all regions and income groups (Fig. 1). The highest age-specific prevalence is in people 60–79 years of age (18.6%), although the largest numbers of people with diabetes are in the 40–59 year age group (184 million). These patterns are expected to persist over the next 20 years. The proportions of adults with diabetes under the age of 50 vary by region and income group with the highest proportion in Africa region (61%) and low-income countries (67%); although there is significant overlap in these figures as most low-income countries are in the Africa region. The greatest proportional increase in the number of people with diabetes by age group is expected to occur in people between 60 and 79 years of age.

4. Discussion

The estimates presented here confirm the large and growing burden of diabetes in the world established by previous estimates. There remains considerable variation in the burden of diabetes across regions and income groups with developing countries disproportionately affected. People with diabetes in high-income countries are predominantly over the age of 50 (74%) while those in low- and middle-income countries are mostly under the age of 50 (59%). Particularly for developing countries, demographic patterns are expected to change substantially over the next generations with increases in life expectancy, decreases in the infectious disease burden, and higher rates of urbanisation. These changes will also drive increases in diabetes prevalence in those countries.

Fig. 1 presents the age-specific prevalence of diabetes when divided by income group and shows a much lower prevalence of diabetes in older adults in low-income countries, compared to higher income countries. This may be a result of a number of factors including: higher mortality in people with diabetes in these countries, or a cohort effect whereby it is younger people developing diabetes. As life expectancy increases, we can expect to see greater numbers of adults with diabetes living longer in these countries which will drive the large proportional increases for low- and middle-income countries over the next generation. In addition, the higher prevalence of diabetes among younger adults in lower and upper middle-income countries will also drive increases as those people age, countries develop, and life expectancy increases. Without concomitant improvements in the health system for early detection and treatment, the rates of complications and deaths due to diabetes can also be expected to increase substantially in these countries. Until prevention and awareness of the disease improves, we cannot expect to see a shift in the curves for low- and middle-income countries towards a decrease in prevalence for younger age groups like that seen for high-income countries.

Table 4 – Top 10 countries/territories for prevalence and number of people with diabetes (20–79 years), 2013 and 2035.

2013		2035	
Country/territory	%	Country/territory	%
Top 10 countries/territories for prevalence[a] (%) of diabetes (20–79 years), 2013 and 2035			
Tokelau	37.5	Tokelau	37.9
Federated States of Micronesia	35.0	Federated States of Micronesia	35.1
Marshall Islands	34.9	Marshall Islands	35.0
Kiribati	28.8	Kiribati	28.9
Cook Islands	25.7	Cook Islands	25.7
Vanuatu	24.0	Saudi Arabia	24.5
Saudi Arabia	24.0	Vanuatu	24.2
Nauru	23.3	Nauru	23.3
Kuwait	23.1	Kuwait	23.2
Qatar	22.9	Qatar	22.8
2013		**2035**	
Country/territory	Millions	Country/territory	Millions
Top 10 countries/territories of number of people with diabetes (20–79 years), 2013 and 2035			
China	98.4	China	142.7
India	65.1	India	109.0
United States of America	24.4	United States of America	29.7
Brazil	11.9	Brazil	19.2
Russian Federation	10.9	Mexico	15.7
Mexico	8.7	Indonesia	14.1
Indonesia	8.5	Egypt	13.1
Germany	7.6	Pakistan	12.8
Egypt	7.5	Turkey	11.8
Japan	7.2	Russian Federation	11.1

[a] Comparative prevalence.

The IDF approach to estimating diabetes prevalence is simple, reproducible, and intentionally conservative. Prevalence estimates for 2013 are derived from the most recent available data with an effort made to minimise extrapolation and use the available evidence to inform the assumptions applied. The estimates are greatly affected by changes in the underlying data. For example, estimates of diabetes in Turkey have increased from previous estimates due to the inclusion of data from the TURDEP-II study [51] showing a prevalence of 16.5%; an increase from the 11.4% estimate from the previous study. Similarly, a new study on the prevalence of diabetes in China published in the Journal of the America Medical Association [114] after the estimates presented here were calculated showed a prevalence of 11.6%, which, if selected for future estimates, would likely increase the prevalence estimate in that country and countries dependent on the data for extrapolation.

Global estimates of diabetes prevalence have shown increases over the past 15 years. The latest estimates surpass projections made by previous estimates. In 1998, King et al. projected that the number of adults with diabetes would reach 300 million by 2025 [115]; and in 2004, the WHO estimated that by 2030 the number would exceed 366 million [116]. In addition, the IDF estimated a global prevalence of 151 million in 2000 [3]; 194 million in 2003 [4]; 246 million in 2006 [5]; 285 million in 2010 [1]; and most recently, 366 million in 2011 [2]. All of these estimates have been surpassed by the estimate in this paper of 382 million in 2013 and we can expect that the projections presented here are likely also to be an underestimate. Each estimate has been based on the latest and highest quality data available. While the methodology has changed and been adapted as more information has become available, the increases seen are likely due to increases in incidence reflected in the availability of newer data reporting increasing prevalence of diabetes. Some increases in prevalence could also be a result of decreases in diabetes mortality where health systems are preventing deaths from complications; however the evidence for this is lacking.

The estimates are also particularly sensitive to the data underlying the assumptions applied to estimate undiagnosed diabetes. As discussed at length in Beagley et al. [11], undiagnosed diabetes is particularly sensitive to the performance of the health system and not to the underlying biology of diabetes. Thus, sampling frames and grouping of countries for extrapolation can have a profound effect on the pooled proportion of undiagnosed diabetes applied to a country. The recent study from China [114] also reported a much higher proportion (70%) of undiagnosed diabetes than previous studies in the same country, which, if included in the future, could have repercussions for estimates in the region.

Changes in the classification of countries used for extrapolation are also likely to have an effect on the way the estimates are calculated. For instance, since the generation of these estimates, the World Bank has reclassified a number of countries into new income group categories [117]. Most notably, the Russian Federation has now been classified as high-income. Because of the way countries are grouped for

extrapolation, and the size of the population in the Russian Federation, this shift is likely to have a substantial effect on future estimates.

The modelling approach used here takes into account only changes in the population and urbanisation for the calculation of the 2035 projections and presents a conservative estimate of the prevalence of diabetes. Thus, increases in obesity and other risk factors for diabetes could drive the prevalence even higher over the next 20 years.

There are more high quality, population-based studies of diabetes available than ever before. For the estimates presented here, 744 data sources were considered and 174 included representing 130 countries. Of those studies, 142 were nationally representative, 69 were based on fasting blood glucose values, and 55 were based on OGTT. There is some regional variability in the availability of high quality data and the Africa region had lowest proportion of countries with original data of sufficient quality for inclusion.

Nationally representative studies are particularly important for high population countries within which regional variability may be considerable. The availability of large, nationally representative, recent studies for India and China, and high quality routine data collection in Mexico, Australia, the United States and Canada, translate to more stability and a higher confidence in the estimates for those countries. However, there is a considerable lack of population-based surveys based on fasting blood glucose or OGTT in high-income countries where self-reported surveys are abundant. This has a particular impact on the estimation of undiagnosed diabetes which leads to more uncertainty in the estimates for those countries.

In conclusion, while it is clear that the availability of more high-quality data is essential to improve the certainty around the estimates of diabetes prevalence, the latest evidence shows that diabetes continues to be a large and increasing global health burden and is likely to continue to grow substantially in the next decades. Increases in diabetes prevalence are driven by rapid development and subsequent changes in lifestyle. Coupled with the comparatively slow development of health systems, diabetes and its complications will continue to be an especially high burden in low- and middle-income countries.

Conflict of interest

The authors have no conflicts of interest to disclose.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.diabres.2013.11.002.

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