Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

Diabetes Atlas

Global estimates of the prevalence of diabetes for 2010 and 2030

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ARTICLE INFO

Article history:
Received 1 October 2009
Accepted 12 October 2009
Published on line 6 November 2009

Keywords:
Diabetes
Prevalence
Ageing
Urbanization

ABSTRACT

Aim: We estimated the number of people worldwide with diabetes for the years 2010 and 2030.

Methods: Studies from 91 countries were used to calculate age- and sex-specific diabetes prevalences, which were applied to national population estimates, to determine national diabetes prevalences for all 216 countries for 2010 and 2030. Studies were identified using Medline, and contact with all national and regional International Diabetes Federation offices. Studies were included if diabetes prevalence was assessed using a population-based methodology, and was based on World Health Organization or American Diabetes Association diagnostic criteria for at least three separate age-groups within the 20–79 year range. Self-report or registry data were used if blood glucose assessment was not available.

Results: The world prevalence of diabetes among adults (aged 20–79 years) will be 6.4%, affecting 285 million adults, in 2010, and will increase to 7.7%, and 439 million adults by 2030. Between 2010 and 2030, there will be a 69% increase in numbers of adults with diabetes in developing countries and a 20% increase in developed countries.

Conclusion: These predictions, based on a larger number of studies than previous estimates, indicate a growing burden of diabetes, particularly in developing countries.

Contents

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0168-8227/$ – see front matter
doi:10.1016/j.diabres.2009.10.007

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 changing lifestyles lead to 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, and 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]. The World Health Organization (WHO) published estimates for the years 2000 and 2030, using data from 40 countries but extrapolated to the 191 WHO member states [4]. Other estimates have been produced by the International Diabetes Federation (IDF) [5,6]. The estimates produced here update the previous IDF estimates, and include all 216 countries of the United Nations.

2. Materials and methods

2.1. Study selection

The Medline database was searched for publications between January 1989 and March 2009, using the following search term ''Diabetes Mellitus/epidemiology'' MeSH AND ''Prevalence'' MeSH. Studies were identified that reported on the prevalence of diabetes for at least three adult age-groups from a population-based sample. A number of other avenues were explored in the search for relevant data. Relevant citations from each article were obtained, and diabetes researchers in

Table 1 – Studies identified for the largest 80 countries.

Country	Data used (country, year of publication, reference)	Screening method	Diagnostic criteria	Sample size	Age range
Africa: Sub-Sahara					
Angola	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Burkina Faso	Cameroon (2006)[a] and Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
Cameroon	Cameroon (2006)[a]	OGTT	WHO-1999	9377	15+
Dem. Rep. of Congo	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Cote d'Ivoire	Cameroon (2006)[a] and Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
Ethiopia	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Ghana	Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
Kenya	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Madagascar	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Malawi	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Mozambique	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Niger	Cameroon (2006)[a] and Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
Nigeria	Cameroon (2006)[a] and Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
Senegal	Cameroon (2006)[a] and Ghana (2002) [27]	OGTT	WHO-1999	14,110	15+
South Africa	South Africa (1993; 1993; 2001; 2008) [28–31]	OGTT	WHO-1985, 1999	3780	15+
Uganda	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
UR Tanzania	Tanzania (1989 and 2000) [25,26]	OGTT/FBG	WHO-1985, 1999	7781	15+
Zimbabwe	South Africa (1993; 1993; 2001; 2008) [28–31]	OGTT	WHO-1985, 1999	3780	15+
Asia					
Bangladesh	Bangladesh (2005, 2003, 2007) [32–34]	OGTT/FBG	WHO-1999, ADA-1997	15,216	20+
Cambodia	Cambodia (2005) [35]	OGTT	WHO-1999	2246	25+
People's Republic of China	People's Republic of China (2003) [16]	FBG	ADA-1997	15,838	35–74
India	India (2001; 2004; 2008) [14,15,36]	OGTT, SR	WHO-1999	69,008	15+
Indonesia	Indonesia (2008) [37]	OGTT	WHO-1999	24,417	15+
Japan	Japan (1993 and 2000) [38,39]	OGTT	WHO-1985	5211	40+
Dem. Rep. of Korea	Republic of Korea (1995) [40]	OGTT	WHO-1985	2520	30+
Republic of Korea	Republic of Korea (2006) [41]	FBG	ADA-1997	5844	21+
Malaysia	Malaysia (2006) [42]	FBG	ADA-1997	34,539	18+
Myanmar	Vietnam (2006) [43]	FBG	WHO-1999	9057	30–64
Nepal	Nepal (2003; 2000; 2006) [44–46]	OGTT, FBG	WHO-1999, 1985	4693	20+
Philippines	Philippines (2004) [47]	OGTT	WHO-1999	7044	20–65
Sri Lanka	Sri Lanka (2008) [48]	OGTT	WHO-1999	4532	18+
Taiwan	Taiwan (1992, 1994) [49,50]	OGTT	WHO-1985	4287	30–79
Thailand	Thailand (2003) [51]	FBG	ADA-1997	5350	35+
Viet Nam	Vietnam (2006) [43]	FBG	WHO-1999	9057	30–64
Europe/North America/Oceania					
Australia	Australia (2002) [52]	OGTT	WHO-1999	11,247	25+
Australia	Australia (2009) [53]	SR	Known diabetes	NA	All ages
Belarus	Poland (2001) [54,55]	OGTT	WHO-1985	6842	35+
Belgium	The Netherlands (1995) [56]	OGTT	WHO-1985	2540	50–74

Table 1 (*Continued*)

Country	Data used (country, year of publication, reference)	Screening method	Diagnostic criteria	Sample size	Age range
Canada	Canada (2007; 2008) [57,58]	Registry	Known diabetes	NA	20+
Czech Republic	Slovakia [59]	OGTT	WHO-1999	1517	18+
France	France (2008) [60]	Treated diabetes		NA	All ages
France	France (2001) [61]	SR and FBG	Known diabetes, ADA 1997	3508	35–64
Germany	Germany (2003) [62]	OGTT	WHO-1999	1353	55–74
Germany	Germany (2007) [63]	SR	Known diabetes	310,000	All ages
Germany	Germany (2008) [64]	FBG	WHO-1999	35,869	18+
Greece	Greece (2005) [65]	FBG	ADA-1997	3032	20+
Hungary	Slovakia [59]	OGTT	WHO-1999	1517	18+
Italy	Italy (2003) [66]	SR	Known diabetes	432,747	15+
Netherlands	The Netherlands (2003) [56]	SR	Known diabetes	155,574	20+
Poland	Poland (2001) [54,55]	OGTT	WHO-1985	6842	35+
Portugal	Portugal (2009)[b]	OGTT	WHO-1999	5147	20–80
Romania	Croatia [67]	FBG	WHO-1999	1653	18–65
Russia	Poland (2001) [54,55]	OGTT	WHO-1985	6842	35+
Serbia	Croatia [67]	FBG	WHO-1999	1653	18–65
Spain	Spain (2003) [68]	SR	Known diabetes	65,651	24+
Spain	Spain (1999; 2004; 2006) [69–71]	OGTT	WHO-1985	9401	20–79
Sweden	Sweden (2002) [72]	OGTT	WHO-1999	6952	25–74
Ukraine	Poland (2001) [54,55]	OGTT	WHO-1985	6842	35+
United Kingdom	England (2002; 2003; 2004; 2009) [73–75][c]	SR	Known diabetes	NA	15 +
United Kingdom	England (2006) [76]	OGTT	WHO-1985	2529	25–75
United States of America	USA (2009) [17]	OGTT	ADA-1997	2806	20+
Latin America/Caribbean					
Argentina	Argentina (2004) [77]	OGTT	WHO-1999	2397	20–69
Brazil	Brazil (1996; 1992; 2003) [78–80]	OGTT	WHO-1985	25,371	30–69
Chile	Chile (2002) [81]	OGTT	WHO-1999	1315	20+
Colombia	Colombia (1993) [82]	2hBG	WHO-1985	670	30–79
Cuba	Jamaica (1999) [83]	OGTT	WHO-1980	1303	25–74
Ecuador	Bolivia (2006) [84]	2hBG	WHO-1985	2948	25+
Guatemala	Nicaragua (2007)[d]	N/A	N/A	1993	20+
Mexico	Mexico (2003; 2005) [85,86]	OGTT/FBG	ADA-1997	84,054	20+
Peru	Bolivia (2006) [84]	2hBG	WHO-1985	2948	25+
Venezuela	Brazil (1996; 1992; 2003) [78–80]	OGTT	WHO-1985	25,371	30–69
Middle-East Crescent					
Afghanistan	Pakistan (1995, 1999, 1999, 2002) [87–90]	OGTT	WHO-1985	6441	25+
Algeria	Algeria (2001) [91]	OGTT	WHO-1985	1457	30–64
Egypt	Egypt (1995 and 1997) [92,93]	OGTT/post prandial GT	WHO-1985	5251	20+
Iran	Iran (2003) [94]	OGTT	WHO-1999	10,368	20+
Iraq	Jordan (1998) [95]	OGTT	WHO-1985	2776	25–79
Kazakhstan	Uzbekistan (1998 and 2002) [96,97]	2hBG	WHO-1994, 1999	2865	35+
Morocco	Morocco (2003) [98]	FBG/SR	WHO-1980	1802	20+
Pakistan	Pakistan (1995, 1999, 1999, 2002) [87–90]	OGTT, FBG	WHO-1985, ADA-1997	5441	25+
Saudi Arabia	Saudi Arabia (1998; 2004; 1997) [99–101]	OGTT	WHO-1985, ADA 1997	47,573	14+
Sudan	Sudan (1996) [102]	2hBG	WHO-1985	1284	25–84
Tunisia	Tunisia (2007) [103]	FBG	ADA-1997	3729	20+
Turkey	Turkey (2002) [24]	2hBG	WHO-1999	24,788	20+
Uzbekistan	Uzbekistan (1998 and 2002) [96,97]	2hBG	WHO-1994, 1999	2865	35+
Yemen	Yemen (2004) [104]	OGTT	WHO-1999	498	20–69

OGTT, oral glucose tolerance test; FBG, fasting blood glucose; 2hBG, 2-h blood glucose; SR, self-report; NA, not available.

[a] J. Mbanya, personal communication (2006).

[b] L. Gardete-Correia, J. Boavida, J. Raposo, S. Massano-Cardoso, C. Mesquita, C. Fona, et al., Diabetes Prevalence Study in Portugal. National Diabetes Program (unpublished data, personal communication) (2009).

[c] S. Wild, personal communication, on behalf of the Scottish Diabetes Research Network, Diabetes prevalence estimates for Scotland (2009).

[d] Organizacion Panamericana de Salud (E. Medina, personal communciation), Prevalence of diabetes in Nicaragua. Managua, 2007.

each major IDF geographical region, and IDF member associations in each member country were asked about relevant data. Studies were included if they assessed diabetes prevalence for a defined adult population-based sample, using WHO or American Diabetes Association (ADA) diagnostic criteria [7–11], with age-specific prevalences indicated for at least three distinct age-groups within the 20–79 year range. Self-report data, or registry data were used if blood glucose

Table 2 – Prevalence of diabetes and estimated diabetes numbers among adults aged 20–79 years for the years 2010 and 2030: 80 most populous countries.

Country	Prevalence (%) adjusted to				Numbers of adults with diabetes (000s)		Mean annual increment (000s)
	World population		National population		2010	2030	
	2010	2030	2010	2030			
Africa: Sub-Sahara							
Angola	3.5	4.7	2.8	3.5	224	506	14
Burkina Faso	3.8	4.6	3.0	3.5	209	470	13
Cameroon	3.9	4.8	4.4	4.8	415	745	16
Cote d'Ivoire	4.7	5.5	4.0	4.4	394	713	16
Dem. Rep. of Congo	3.2	4.4	2.6	3.2	743	1,760	51
Ethiopia	2.5	3.5	2.0	2.8	826	2,031	60
Ghana	4.3	5.2	3.6	4.3	458	896	22
Kenya	3.5	4.7	2.8	3.7	519	1,231	36
Madagascar	3.2	4.4	2.7	3.5	270	640	18
Malawi	2.3	3.3	1.8	2.3	115	266	8
Mozambique	4.0	5.1	3.3	3.7	329	585	13
Niger	3.9	4.7	3.4	3.7	224	499	14
Nigeria	4.7	5.5	3.9	4.3	2,819	5,316	125
Senegal	4.7	5.6	4.0	4.5	256	503	12
South Africa	4.5	5.6	4.5	4.9	1,283	1,644	18
Uganda	2.2	3.1	1.7	2.2	224	617	20
UR Tanzania	3.2	4.3	2.6	3.3	504	1,155	33
Zimbabwe	4.1	5.3	3.4	4.0	235	389	8
Asia							
Bangladesh	6.6	7.9	6.1	7.4	5,681	10,423	237
Cambodia	5.2	6.5	4.3	5.6	354	724	19
China	4.2	5.0	4.5	5.8	43,157	62,553	970
Dem. Rep. of Korea	5.3	6.2	5.7	6.8	943	1,256	16
India	7.8	9.3	7.1	8.6	50,768	87,036	1813
Indonesia	4.8	5.9	4.6	6.0	6,964	11,980	251
Japan	5.0	5.9	7.3	8.0	7,089	6,879	−11
Malaysia	11.6	13.8	10.9	13.4	1,846	3,245	70
Myanmar	3.2	4.3	2.8	4.3	922	1,755	42
Nepal	3.9	5.2	3.3	4.2	511	1,070	28
Philippines	7.7	8.9	6.7	7.8	3,398	6,164	138
Republic of Korea	7.9	9.0	9.0	11.4	3,292	4,323	52
Sri Lanka	10.9	13.5	11.5	14.9	1,529	2,158	31
Taiwan	7.5	8.5	5.7	6.8	816	1,232	21
Thailand	7.1	8.4	7.7	9.8	3,538	4,956	71
Viet Nam	3.5	4.4	2.9	4.4	1,647	3,415	88
Europe/North America/Oceania							
Australia	5.7	6.8	7.2	8.4	1,086	1,503	21
Belarus	7.6	9.0	9.1	11.1	661	725	3
Belgium	5.3	6.7	8.0	9.6	610	750	7
Canada	9.2	10.9	11.6	13.9	2,866	3,981	56
Czech Republic	6.4	7.8	8.7	10.7	677	793	6
France	6.7	8.3	9.4	11.0	4,164	5,201	52
Germany	8.9	10.2	12.0	13.5	7,494	8,014	26
Greece	6.0	7.4	8.8	10.3	754	875	6
Hungary	6.4	7.8	8.8	10.3	659	727	3
Italy	5.9	7.2	8.8	10.4	3,926	4,483	28
Netherlands	5.3	6.7	7.7	9.5	922	1,178	13
Poland	7.6	9.0	9.3	11.6	2,675	3,153	24
Portugal	9.6	11.2	12.2	14.4	978	1143	8
Romania	6.9	8.0	8.4	10.0	1,351	1,469	6
Russian Federation	7.6	9.0	9.0	10.9	9,625	10,330	35
Serbia	6.9	8.0	8.6	9.5	613	687	4
Spain	6.6	8.0	8.7	11.1	2,939	3,866	46
Sweden	5.2	6.2	7.3	8.0	484	556	4
Ukraine	7.6	9.0	9.6	11.3	3,328	3,349	1
United Kingdom	3.6	4.3	4.9	5.4	2,140	2,549	20
USA	10.3	12.0	12.3	14.0	26,814	35,958	457

Table 2 (*Continued*)

Country	Prevalence (%) adjusted to				Numbers of adults with diabetes (000s)		Mean annual increment (000s)
	World population		National population		2010	2030	
	2010	2030	2010	2030			
Latin America/Caribbean							
Argentina	5.7	6.5	6.0	6.6	1,558	2,158	30
Brazil	6.4	7.7	6.0	7.8	7,633	12,708	254
Chile	5.7	6.5	6.1	7.2	699	1,006	15
Colombia	5.2	6.2	4.8	6.3	1,427	2,506	54
Cuba	9.5	10.9	11.0	13.5	903	1,143	12
Ecuador	5.9	7.1	5.5	6.8	443	753	15
Guatemala	8.6	10.6	6.9	8.0	465	983	26
Mexico	10.8	12.9	10.1	13.3	6,827	11,910	254
Peru	6.2	7.3	5.6	7.0	962	1,666	35
Venezuela	6.5	7.8	5.9	7.4	1,034	1,840	40
Middle-East Crescent							
Afghanistan	8.6	9.9	6.6	7.0	856	1,726	43
Algeria	8.5	9.4	7.4	9.3	1,632	2,850	61
Egypt	11.4	13.7	10.4	12.8	4,787	8,615	191
Iran (Islamic Rep. of)	8.0	9.8	6.1	9.3	2,872	5,981	155
Iraq	10.2	12.0	7.8	9.3	1,176	2,605	71
Kazakhstan	5.8	7.0	5.6	7.1	584	843	13
Morocco	8.3	9.8	7.6	9.7	1,513	2,589	54
Pakistan	9.1	10.5	7.6	9.3	7,146	13,833	334
Saudi Arabia	16.8	18.9	13.6	17.0	2,065	4,183	106
Sudan	4.2	5.2	3.3	4.0	675	1,367	35
Syrian Arab Republic	10.8	13.2	8.3	11.0	974	2,099	56
Tunisia	9.3	11.0	8.5	11.7	602	1,052	22
Turkey	8.0	9.4	7.4	9.6	3,679	6,323	132
Uzbekistan	5.2	6.6	4.0	5.8	674	1,407	37
Yemen	3.0	3.5	2.5	2.9	270	622	18

assessment was not available. The final selection of a study or studies for each country was determined by the study size, response rate, diagnostic criteria used (with preference for the oral glucose tolerance test) and by assessing the degree to which studies reflected the national population. The final selection included 133 studies from 91 countries. For those countries that did not have their own suitable study, a study (or studies) from another country were used, with selection of that study on the basis of the ethnic and socio-economic similarity of the population, as well as geographical proximity. National member associations of the IDF assisted with choice of which other country to use. Estimates were based on the total diabetes population, including those newly diagnosed on blood glucose testing by surveys, and those with type 1 diabetes.

2.2. *Statistical methods*

Prevalence estimates were derived for adults aged 20–79 years. Smoothed age-specific (5 year intervals) and sex-specific prevalence estimates were generated by applying logistic regression models using SPSS Version 15.0 (SPSS, Chicago, IL) to the available data, including a quadratic term to allow flattening for older ages. The age-specific data were centred on the mid-point of each age-group, and weighted by the number of cases with and without diabetes. Open-ended age-groups (such as 65+) were treated as if the open age-group were of the same size as the highest inclusive group (e.g. 55–64).

The smoothed age- and sex-specific prevalences were then applied to each national population distribution for the years 2010 and 2030 (United Nations Population estimates [12]) 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. For countries designated as developing, by the UN classification [12] (i.e. all countries outside Europe, except Australia, Canada, Japan, New Zealand, USA, Singapore, Hong Kong and Taiwan), for which separate urban and rural prevalences were available, these were applied to the urban and rural components of the national adult population. For cases in which only urban or only rural data were available, urban prevalences were assumed to be twice those of rural, in keeping with previous assessments [1]. For the countries with multiple studies, data were combined. The same age- and sex-specific prevalence data were applied to 2010 and 2030, so that changes in national estimates were only affected by demographic (i.e. age, sex and urbanization) changes for each country.

Countries were assigned to regions based on the IDF membership regions (Africa; Eastern Mediterranean and Middle-East (EMME); Europe; North America; South and Central America (SACA); South Asia; Western Pacific).

For several of the studies (Canada, France, Italy, Netherlands, Norway, Slovenia, United Kingdom) data were only available on self-reported diabetes. To account for undiagnosed

Table 3 – Prevalence[a] of diabetes and estimated diabetes numbers by region among adults aged 20–79 years for the years 2010 and 2030.

	2010			2030			2010/2030
	Total adult population (000s)	No. of adults with diabetes (000s)	Diabetes prevalence (%)	Total adult population (000s)	No. of adults with diabetes (000s)	Diabetes prevalence (%)	Increase in the no. of adults with diabetes (%)
Africa	379	12.1	3.8	653	23.9	4.7	98.1
EMME	344	26.6	9.3	533	51.7	10.8	93.9
Europe	646	55.4	6.9	659	66.5	8.1	20.0
N America	320	37.4	10.2	390	53.2	12.1	42.4
S & C America	287	18.0	6.6	382	29.6	7.8	65.1
S Asia	838	58.7	7.6	1200	101.0	9.1	72.1
W Pacific	1531	76.7	4.7	1772	112.8	5.7	47.0
World	4345	284.8	6.4	5589	438.7	7.7	54.1

[a] Prevalences for each region are standardized to world age distribution of that year.

diabetes, the prevalences of diabetes for the United Kingdom and Canada were multiplied by a factor of 1.5, in accordance with local recommendation (UK) and data from the USA (Canada), and for the other countries doubled, based on data from a number of nearby countries.

3. Results

There were 133 studies identified from 91 countries. The data sources and the results for the 80 most populous countries (those with 2010 adult population of greater than 6.307 million, with a combined 2010 population of 95% of the world adult population) are shown in Tables 1 and 2. There were 47 of the 80 countries that had their own data (85 separate studies). Details of prevalence and case numbers for all 216 countries can be found in the online Appendix.

The highest regional prevalence (Table 3) for 2010 (after age-standardization to the world population) was for North America, followed by the EMME and South Asia. The African region is expected to have the largest proportional increase in adult diabetes numbers by 2030, followed by the EMME, though North America will continue to have the world's highest prevalence. 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% over the 20 years.

Considering only the 91 countries in which prevalence studies have been undertaken, 5 of the 10 world's highest national prevalences occur in the Middle-East (Table 4), although only Saudi Arabia (18.7%) is among the 80 most populous. The Gulf States have prevalences similar to that of Saudi Arabia, and 20 of the EMME Region's 22 countries have prevalences above the world 2010 prevalence of 6.4%.

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 Bangladesh and Nigeria of the world's 10 most populous countries are not among the 10 countries with the highest diabetes numbers (replaced by Germany and Mexico) for 2010.

There are marked differences between developed and developing countries. Fig. 1 shows current estimated numbers of people with diabetes by age-group for 2010 and 2030. For developing countries, adult diabetes numbers are likely to increase by 69% from 2010 to 2030, compared to 20% for developed countries, whereas total adult populations are expected to increase by 36% and 2% respectively. For the developing countries, increases in diabetes numbers are expected for each age-group, with a doubling for the over 60-year age-group. For developed countries, an increase (38%) is only expected amongst the over 60s, with slight decreases predicted for the younger age-groups. Currently, the greatest

Table 4 – Top 10 countries for diabetes prevalence in 2010 and 2030.

	2010		2030	
	Country	Prevalence (%)	Country	Prevalence (%)
1	Nauru	30.9	Nauru	33.4
2	United Arab Emirates	18.7	United Arab Emirates	21.4
3	Saudi Arabia	16.8	Mauritius	19.8
4	Mauritius	16.2	Saudi Arabia	18.9
5	Bahrain	15.4	Reunion	18.1
6	Reunion	15.3	Bahrain	17.3
7	Kuwait	14.6	Kuwait	16.9
8	Oman	13.4	Tonga	15.7
9	Tonga	13.4	Oman	14.9
10	Malaysia	11.6	Malaysia	13.8

Only includes countries where surveys with blood glucose testing were undertaken for that country.

Table 5 – Top 10 countries for numbers of people aged 20–79 years with diabetes in 2010 and 2030.

	2010		2030	
	Country	No. of adults with diabetes (millions)	Country	No. of adults with diabetes (millions)
1	India	50.8	India	87.0
2	China	43.2	China	62.6
3	USA	26.8	USA	36.0
4	Russian Federation	9.6	Pakistan	13.8
5	Brazil	7.6	Brazil	12.7
6	Germany	7.5	Indonesia	12.0
7	Pakistan	7.1	Mexico	11.9
8	Japan	7.1	Bangladesh	10.4
9	Indonesia	7.0	Russian Federation	10.3
10	Mexico	6.8	Egypt	8.6

number of people worldwide with diabetes is in the 40–59 year-old age-group, but by 2030, there will be slightly more people with diabetes in the 60–79 year-old age-group.

The overall total predicted increase in numbers with diabetes from 2010 to 2030 is 54%, at an annual growth of 2.2%, which is nearly twice the annual growth of the total world adult population. Thirty-six percent of the anticipated absolute global increase of 154 million people with diabetes is projected to occur in India and China alone.

4. Discussion

These estimates suggest that in 2010 there will be 285 million people worldwide with diabetes, with considerable disparity between populations and regions. The pattern of diabetes varies considerably according to countries' economic status. For developed countries, the majority with diabetes are aged over 60 years, whereas for developing countries most people with diabetes are of working age, between 40 and 60 years. This difference is likely to still be present in 2030, although less marked, as the average age of developing countries' populations will increase slightly more than in the developed countries. Population growth, ageing of populations, and urbanization with associated lifestyle change is likely to lead to a 54% increase in worldwide numbers with diabetes by 2030.

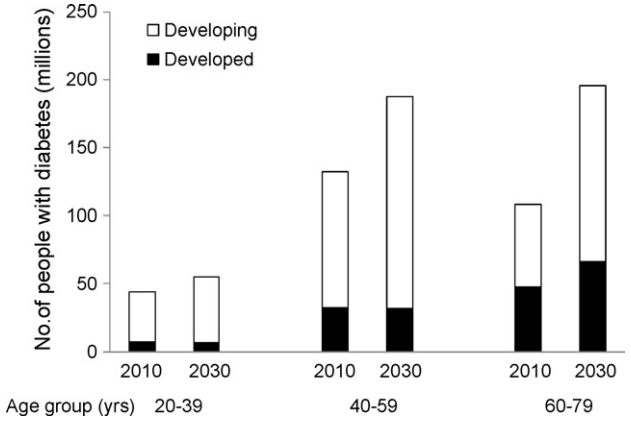

Fig. 1 – Numbers of adults with diabetes in developed and developing countries in 2010 and 2030, according to age-group.

These projections are somewhat higher than predictions made only a few years ago [4], with a greater discrepancy from those made in 1998 [2]. The current estimate for 2010 of 285 million adults with diabetes is 67% higher than the 2004 published estimate for the year 2000 [4], and our 2030 estimate of 439 million is 20% higher than the same study's estimate for 2030 [4]. Comparisons with other older estimates show even greater differences. In 1998, King et al. [2] estimated 300 million adults with diabetes for 2025. We used a different statistical technique to that used in the most recent WHO estimates [4], but doubt that this is the cause for the increase in prevalence, as prevalences tended to be similar for those countries based on the same original studies, but differed when based on different reports (which applied for the majority of cases). We believe that the increases reported in the current estimates are likely to relate to the use of more recent studies, most of which reported higher prevalences than earlier studies; this was the case for a number of the largest countries, with newer reports showing higher prevalences for India [13–15], China [16], and USA [17] than those used previously [18–20].

Thus, the likeliest explanation for the differences is that prevalence is genuinely increasing, as a consequence of increasing incidence (due to demographic changes such as ageing, and as the undesirable 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.

We have not addressed the issues of changing incidence, nor whether medical care will increase lifespan with diabetes. We have based our projections for 2030 on predicted demographic changes: urbanization and ageing. Urbanization in developing countries is associated with a more sedentary lifestyle tending to increase diabetes prevalence [18], so to some extent is a proxy for lifestyle changes. The challenge is to minimize the detriments of urbanization, as the process is unlikely to be reversed. Specific lifestyle intervention programs have been shown to be efficacious [21,22] in reducing diabetes incidence. Apart from the impact of urbanization, we have not attempted to 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 figures.

The principal issue of course is the accuracy of our estimates. The major limitations are paucity of data, which applies varyingly throughout the world, and the representativeness of studies chosen. Thus, only 37 out of the 133 studies were national studies, with only two of these (Iceland, Turkey [23,24]) in Europe. Studies were only available from 5 out of 50 sub-Saharan African countries, and data from Poland were used for 7 Eastern European countries. There is a clear need for more studies on the prevalence of diabetes. We can have most confidence in results from regions where repeated surveys have shown similar patterns. This particularly applies to the Middle-East, and small Pacific Island states, where a number of surveys has quantified the problem.

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

In summary, these results serve as another piece of evidence that diabetes is continuing to be an increasing international health burden. The estimates here are higher than those previously made [4], which supports the concern that they were conservative, and that the prevalence of diabetes continues to rise. Ageing and urbanization are increasingly adding to the burden of diabetes in developing countries, where resources for dealing with the associated clinical problems are most scarce.

Conflict of interest

There are no conflicts of interest.

Acknowledgements

The authors would like to thank the members of the IDF *Diabetes Atlas* Committee (JC Mbanya, D Gan, B Allgot, K Bakker, J Brown, A Ramachandran, M Silink, L Siminerio, G Soltesz, R Williams) for their advice in compiling these estimates. Funding was provided by the IDF.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.diabres.2009.10.007.

REFERENCES

[1] H. King, M. Rewers, Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults, Diabetes Care 16 (1) (1993) 157–177.

[2] H. King, R. Aubert, W. Herman, Global burden of diabetes, 1995–2025: prevalence, numerical estimates and projections, Diabetes Care 21 (9) (1998) 1414–1431.

[3] A. Amos, D. McCarty, P. Zimmet, The rising global burden of diabetes and its complications: estimates and projections to the year 2010, Diabet. Med. 14 (Suppl. 5) (1997) S1–S85.

[4] S. Wild, G. Roglic, A. Green, R. Sicree, H. King, Global prevalence of diabetes: estimates for the year 2000 and projections for 2030, Diabetes Care 27 (5) (2004) 1047–1053.

[5] International Diabetes Federation, Diabetes Atlas, 2nd ed., International Diabetes Federation, Brussels, 2003.

[6] International Diabetes Federation, Diabetes Atlas, 3rd ed., International Diabetes Federation, Brussels, 2006.

[7] World Health Organization, Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Department of Noncommunicable Disease Surveillance, Geneva, 1999. Report No.: WHO/NCD/NCS/99.2.

[8] World Health Organization, Diabetes mellitus: report of a WHO Study Group. Technical Report Series 727. WHO, Geneva, 1985.

[9] American Diabetes Association, Report of the Expert Committee on the diagnosis and classification of diabetes mellitus, Diabetes Care 20 (1997) 1183–1197.

[10] World Health Organization, Expert Committee on diabetes mellitus, second report. Technical Report Series 646. WHO, Geneva, 1980.

[11] World Health Organization, Prevention of diabetes mellitus. Technical Report Series no. 844. World Health Organization, Geneva, 1994.

[12] United Nations, Population Division, World Population Prospects: The 2006 Revision. United Nations (Ed.). Geneva, 2007.

[13] B. Shah, K. Anand, P. Joshi, J. Mahanta, V. Mohan, K. Thankappan, et al. Report of the surveillance of risk factors of non-communicable diseases (STEPS 1 and 2) from five centres in India—WHO India-ICMR initiative. New Delhi: http://www.whoindia.org/LinkFiles/NCD_Surveillance_NCD_RF_surveillance_report.pdf2004.

[14] S.M. Sadikot, A. Nigam, S. Das, S. Bajaj, A.H. Zargar, K.M. Prasannakumar, et al., The burden of diabetes and impaired glucose tolerance in India using the WHO 1999 criteria: prevalence of diabetes in India study (PODIS), Diabetes Res. Clin. Pract. 66 (3) (2004) 301–307.

[15] A. Ramachandran, C. Snehalatha, A. Kapur, V. Vijay, V. Mohan, A.K. Das, et al., High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey, Diabetologia 44 (9) (2001) 1094–1101.

[16] D. Gu, K. Reynolds, X. Duan, X. Xin, J. Chen, X. Wu, et al., Prevalence of diabetes and impaired fasting glucose in the Chinese adult population: International Collaborative Study of Cardiovascular Disease in Asia (InterASIA), Diabetologia 46 (9) (2003) 1190–1198.

[17] C.C. Cowie, K.F. Rust, E.S. Ford, M.S. Eberhardt, D.D. Byrd-Holt, C. Li, et al., Full accounting of diabetes and pre-diabetes in the U.S. population in 1988–1994 and 2005–2006, Diabetes Care 32 (2) (2009) 287–294.

[18] A. Ramachandran, C. Snehalatha, E. Latha, M. Manoharan, V. Vijay, Impacts of urbanisation on the lifestyle and on the prevalence of diabetes in native Asian Indian population, Diabetes Res. Clin. Pract. 44 (3) (1999) 207–213.

[19] X.-R. Pan, W.-Y. Yang, G.-W. Li, J. Lui, The National Diabetes Prevention and Control Cooperative Group, Prevalence of diabetes and its risk factors in China, Diabetes Care 20 (1997) 1664–1669.

[20] C.C. Cowie, K.F. Rust, D.D. Byrd-Holt, M.S. Eberhardt, K.M. Flegal, M.M. Engelgau, et al., Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population:

National Health and Nutrition Examination Survey 1999–2002, Diabetes Care 29 (6) (2006) 1263–1268.
[21] X. Pan, G. Li, Y. Hu, J. Wang, W. Yang, Z. An, et al., Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study, Diabetes Care 20 (1997) 537–544.
[22] A. Ramachandran, C. Snehalatha, S. Mary, B. Mukesh, A.D. Bhaskar, V. Vijay, The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1), Diabetologia 49 (2) (2006) 289–297.
[23] S. Vilbergsson, G. Sigurdsson, H. Sigvaldason, A. Hreidarsson, N. Sigfusson, Prevalence and incidence of NIDDM in Iceland: evidence for stable incidence among males and females 1967–1991—the Reykjavik Study, Diabet. Med. 14 (1997) 491–498.
[24] I. Satman, T. Yilmaz, A. Sengul, S. Salman, F. Salman, S. Uygur, et al., Population-based study of diabetes and risk characteristics in Turkey: results of the Turkish diabetes epidemiology study (TURDEP), Diabetes Care 25 (9) (2002) 1551–1556.
[25] D. McLarty, H. Kitange, B. Mtinangi, W. Makene, A. Swai, G. Masuki, et al., Prevalence of diabetes and impaired glucose tolerance in rural Tanzania, Lancet (1989) 871–874.
[26] T.J. Aspray, F. Mugusi, S. Rashid, D. Whiting, R. Edwards, K.G. Alberti, et al., Rural and urban differences in diabetes prevalence in Tanzania: the role of obesity, physical inactivity and urban living, Trans. R. Soc. Trop. Med. Hyg. 94 (6) (2000) 637–644.
[27] A.G. Amoah, S.K. Owusu, S. Adjei, Diabetes in Ghana: a community based prevalence study in Greater Accra, Diabetes Res. Clin. Pract. 56 (3) (2002) 197–205.
[28] M. Omar, M. Seedat, A. Motala, R. Dyer, P. Becker, The prevalence of diabetes mellitus and impaired glucose tolerance in a group of urban South African blacks, SAMJ 83 (1993) 641–643.
[29] N. Levitt, J. Katzenellenbogen, D. Bradshaw, M. Hoffman, F. Bonnici, The prevalence and identification of risk factors for NIDDM in urban Africans in Cape Town, South Africa, Diabetes Care 16 (4) (1993) 601–607.
[30] R.T. Erasmus, E. Blanco Blanco, A.B. Okesina, T. Matsha, Z. Gqweta, J.A. Mesa, Prevalence of diabetes mellitus and impaired glucose tolerance in factory workers from Transkei, South Africa, SAMJ 91 (2) (2001) 157–160.
[31] A.A. Motala, T. Esterhuizen, E. Gouws, F.J. Pirie, M.A. Omar, Diabetes and other disorders of glycemia in a rural South African community: prevalence and associated risk factors, Diabetes Care 31 (9) (2008) 1783–1788.
[32] A. Hussain, M.A. Rahim, A.K. AzadKhan, S.M. Ali, S. Vaaler, Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh, Diabet. Med. 22 (7) (2005) 931–936.
[33] M.A. Sayeed, H. Mahtab, P. AkterKhanam, Z. AbdulLatif, S.M. KeramatAli, A. Banu, et al., Diabetes and impaired fasting glycemia in a rural population of Bangladesh, Diabetes Care 26 (4) (2003) 1034–1039.
[34] M.A. Rahim, A. Hussain, A.K. AzadKhan, M.A. Sayeed, S.M. KeramatAli, S. Vaaler, Rising prevalence of type 2 diabetes in rural Bangladesh: a population based study, Diabetes Res. Clin. Pract. 77 (2) (2007) 300–305.
[35] H. King, L. Keuky, S. Seng, T. Khun, G. Roglic, M. Pinget, Diabetes and associated disorders in Cambodia: two epidemiological surveys, Lancet 366 (9497) (2005) 1633–1639.
[36] V. Mohan, P. Mathur, R. Deepa, M. Deepa, D.K. Shukla, G.R. Menon, et al., Urban rural differences in prevalence of self-reported diabetes in India—the WHO-ICMR Indian NCD risk factor surveillance, Diabetes Res. Clin. Pract. 80 (1) (2008) 159–168.
[37] Ministry of Health, Republic of Indonesia, National Basic Health Research 2007, Official Report (translated from RISKESDAS 2007, Sidartawan Soegondo), Jakarta, 2008.
[38] T. Ohmura, K. Ueda, Y. Kiyohara, H. Kato, K. Nakayama, K. Nomiyama, et al., Prevalence of type 2 (non-insulin dependent) diabetes mellitus and impaired glucose tolerance in the Japanese general population: the Hisayama study, Diabetologia 36 (1993) 1198–1203.
[39] A. Sekikawa, H. Eguchi, M. Tominaga, K. Igarashi, T. Abe, H. Manaka, et al., Prevalence of type 2 diabetes mellitus and impaired glucose tolerance in a rural area of Japan. The Funagata diabetes study, J. Diabetes Complications 14 (2) (2000) 78–83.
[40] Y. Park, H. Lee, C. Koh, H. Min, K. Yoo, Y. Kim, et al., Prevalence of diabetes and IGT in Yonchon County, South Korea, Diabetes Care 18 (4) (1995) 545–548.
[41] S.M. Kim, J.S. Lee, J. Lee, J.K. Na, J.H. Han, D.K. Yoon, et al., Prevalence of diabetes and impaired fasting glucose in Korea: Korean National Health and Nutrition Survey 2001, Diabetes Care 29 (2) (2006) 226–231.
[42] Institute for Public Health, Ministry of Health Malaysia, Diabetes Mellitus, 2006.
[43] Ministry of Health, Vietnam, Follow-up study on diabetic complications in patients since their first presentation at National Hospital of Endocrinology, TaVan Binh (Ed.), Ha Noi, 2006.
[44] D.L. Singh, M.D. Bhattarai, High prevalence of diabetes and impaired fasting glycaemia in urban Nepal, Diabet. Med. 20 (2) (2003) 170–171.
[45] P. Karki, N. Baral, M. Lamsal, S. Rijal, B.C. Koner, S. Dhungel, et al., Prevalence of non-insulin dependent diabetes mellitus in urban areas of eastern Nepal: a hospital based study, Southeast Asian J. Trop. Med. Public Health 31 (1) (2000) 163–166.
[46] U.K. Shrestha, D.L. Singh, M.D. Bhattarai, The prevalence of hypertension and diabetes defined by fasting and 2-h plasma glucose criteria in urban Nepal, Diabet. Med. 23 (10) (2006) 1130–1135.
[47] J.C. Baltazar, C.A. Ancheta, I.B. Aban, R.E. Fernando, M.M. Baquilod, Prevalence and correlates of diabetes mellitus and impaired glucose tolerance among adults in Luzon, Philippines, Diabetes Res. Clin. Pract. 64 (2) (2004) 107–115.
[48] P. Katulanda, G.R. Constantine, J.G. Mahesh, R. Sheriff, R.D. Seneviratne, S. Wijeratne, et al., Prevalence and projections of diabetes and pre-diabetes in adults in Sri Lanka—Sri Lanka Diabetes, Cardiovascular Study (SLDCS), Diabet. Med. 25 (9) (2008) 1062–1069.
[49] P. Chou, H. Chen, K. Hsiao, Community-based epidemiological study on diabetes in Pu-Li, Taiwan, Diabetes Care 15 (1) (1992) 81–89.
[50] P. Chou, M. Liao, H. Kuo, K. Hsiao, S. Tsai, A population survey on the prevalence of diabetes in Kin-Hu, Kinmen, Diabetes Care 17 (9) (1994) 1055–1058.
[51] W. Aekplakorn, R.P. Stolk, B. Neal, P. Suriyawongpaisal, V. Chongsuvivatwong, S. Cheepudomwit, et al., The prevalence and management of diabetes in Thai adults: the international collaborative study of cardiovascular disease in Asia, Diabetes Care 26 (10) (2003) 2758–2763.
[52] D.W. Dunstan, P.Z. Zimmet, T.A. Welborn, M.P. de Courten, A.J. Cameron, R.A. Sicree, et al., The rising prevalence of diabetes and impaired glucose tolerance: the Australian Diabetes, Obesity and Lifestyle Study, Diabetes Care 25 (5) (2002) 829–834.
[53] National Diabetes Service Scheme, Diabetes Australia, 2009 [cited 2009, 14/1/2009]. Available from: http://www.ndss.com.au/Australian-Diabetes-Map/Map/.
[54] M. Szurkowska, Z. Szybinski, A. Nazim, K. Szafraniec, W. Jedrychowski, Prevalence of type II diabetes mellitus in

population of Krakow, Pol. Arch. Med. Wewn. 106 (3) (2001) 771–779.
[55] J. Lopatynski, G. Mardarowicz, T. Nicer, G. Szczesniak, H. Krol, A. Matej, et al., The prevalence of type II diabetes mellitus in rural urban population over 35 years of age in Lublin region (Eastern Poland), Pol. Arch. Med. Wewn. 106 (3) (2001) 781–786.
[56] L.J. Ubink-Veltmaat, H.J. Bilo, K.H. Groenier, S.T. Houweling, R.O. Rischen, B. Meyboom-deJong, Prevalence, incidence and mortality of type 2 diabetes mellitus revisited: a prospective population-based study in The Netherlands (ZODIAC-1), Eur. J. Epidemiol. 18 (8) (2003) 793–800.
[57] L.L. Lipscombe, J.E. Hux, Trends in diabetes prevalence, incidence, and mortality in Ontario, Canada 1995–2005: a population-based study, Lancet 369 (9563) (2007) 750–756.
[58] Public Health Agency of Canada, Report from the National Diabetes Surveillance System: diabetes in Canada, 2008 [cited 2009, 1/2/2009].
[59] M. Mokan, P. Galajda, D. Pridavkova, V. Tomaskova, L. Sutarik, L. Krucinska, et al., Prevalence of diabetes mellitus and metabolic syndrome in Slovakia, Diabetes Res. Clin. Pract. 81 (2) (2008) 238–242.
[60] O. Kusnik-Joinville, A. Weill, B. Salanave, P. Ricordeau, H. Allemand, Prevalence and treatment of diabetes in France: trends between 2000 and 2005, Diabetes Metab. 34 (3) (2008) 266–272.
[61] P. Gourdy, J.B. Ruidavets, J. Ferrieres, P. Ducimetiere, P. Amouyel, D. Arveiler, et al., Prevalence of type 2 diabetes and impaired fasting glucose in the middle-aged population of three French regions—the MONICA study 1995–97, Diabetes Metab. 27 (3) (2001) 347–358.
[62] W. Rathmann, B. Haastert, A. Icks, H. Lowel, C. Meisinger, R. Holle, et al., High prevalence of undiagnosed diabetes mellitus in Southern Germany: target populations for efficient screening. The KORA survey 2000, Diabetologia 46 (2) (2003) 182–189.
[63] H. Hauner, I. Koster, L. von Ferber, Prevalence of diabetes mellitus and quality of care in Hesse, Germany, 1998–2004, Dtsch. Arztebl. 104 (41) (2007) A2799–A2805.
[64] H. Hauner, J. Hanisch, P. Bramlage, E. Steinhagen-Thiessen, H. Schunkert, K.H. Jockel, et al., Prevalence of undiagnosed type-2-diabetes mellitus and impaired fasting glucose in German primary care: data from the German Metabolic and Cardiovascular Risk Project (GEMCAS), Exp. Clin. Endocrinol. Diabetes 116 (1) (2008) 18–25.
[65] D.B. Panagiotakos, C. Pitsavos, C. Chrysohoou, C. Stefanadis, The epidemiology of type 2 diabetes mellitus in Greek adults: the ATTICA study, Diabet. Med. 22 (11) (2005) 1581–1588.
[66] C. Cricelli, G. Mazzaglia, F. Samani, M. Marchi, A. Sabatini, R. Nardi, et al., Prevalence estimates for chronic diseases in Italy: exploring the differences between self-report and primary care databases, J. Public Health Med. 25 (3) (2003) 254–257.
[67] Z. Metelko, I. Pavlic-Renar, T. Poljicanin, L. Szirovitza, S. Turek, Prevalence of diabetes mellitus in Croatia, Diabetes Res. Clin. Pract. 81 (2) (2008) 263–267.
[68] J.M. Arteagoitia, M.I. Larranaga, J.L. Rodriguez, I. Fernandez, J.A. Pinies, Incidence, prevalence and coronary heart disease risk level in known type 2 diabetes: a sentinel practice network study in the Basque Country, Spain, Diabetologia 46 (7) (2003) 899–909.
[69] C. Castell, R. Tresserras, J. Serra, A. Goday, G. Lloveras, L. Salleras, Prevalence of diabetes in Catalonia (Spain): an oral glucose tolerance test-based population study, Diabetes Res. Clin. Pract. 43 (1) (1999) 33–40.
[70] R. Masia, J. Sala, I. Rohlfs, R. Piulats, J.M. Manresa, J. Marrugat, Prevalence of diabetes mellitus in the province of Girona, Spain: the REGICOR study, Rev. Espanola Cardiol. 57 (3) (2004) 261–264.
[71] J.C. Valverde, M.J. Tormo, C. Navarro, M. Rodriguez-Barranco, R. Marco, J.M. Egea, et al., Prevalence of diabetes in Murcia (Spain): a Mediterranean area characterised by obesity, Diabetes Res. Clin. Pract. 71 (2) (2006) 202–209.
[72] M. Eliasson, B. Lindahl, V. Lundberg, B. Stegmayr, No increase in the prevalence of known diabetes between 1986 and 1999 in subjects 25–64 years of age in northern Sweden, Diabet. Med. 19 (10) (2002) 874–880.
[73] J.N. Harvey, L. Craney, D. Kelly, Estimation of the prevalence of diagnosed diabetes from primary care and secondary care source data: comparison of record linkage with capture–recapture analysis, J. Epidemiol. Community Health 56 (1) (2002) 18–23.
[74] G.V. Gill, A.A. Ismail, N.J. Beeching, S.B. Macfarlane, M.A. Bellis, Hidden diabetes in the UK: use of capture–recapture methods to estimate total prevalence of diabetes mellitus in an urban population, J. R. Soc. Med. 96 (7) (2003) 328–332.
[75] Department of Health, United Kingdom, Health Survey for England 2003: Risk Factors for Cardiovascular Disease, The Stationery Office, London, 2004.
[76] N.G. Forouhi, D. Merrick, E. Goyder, B.A. Ferguson, J. Abbas, K. Lachowycz, et al., Diabetes prevalence in England, 2001—estimates from an epidemiological model, Diabet. Med. 23 (2) (2006) 189–197.
[77] M.S. de Sereday, C. Gonzalez, D. Giorgini, L. De Loredo, J. Braguinsky, C. Cobenas, et al., Prevalence of diabetes, obesity, hypertension and hyperlipidemia in the central area of Argentina, Diabetes Metab. 30 (4) (2004) 335–339.
[78] J. Oliveira, A. Milech, L. Franco, Prevalence TBCGotSoD, The prevalence of diabetes in Rio de Janeiro, Brazil, Diabetes Care 19 (6) (1996) 663–666.
[79] D. Malerbi, L. Franco, Multicenter study of the prevalence of diabetes mellitus and impaired glucose tolerance in the urban Brazilian population aged 30–69 yr, Diabetes Care 15 (11) (1992) 1509–1516.
[80] M.T. Torquato, R.M. Montenegro Junior, L.A. Viana, R.A. de Souza, C.M. Lanna, J.C. Lucas, et al., Prevalence of diabetes mellitus and impaired glucose tolerance in the urban population aged 30–69 years in Ribeirao Preto (Sao Paulo), Brazil, Sao Paulo Med. J. 121 (6) (2003) 224–230.
[81] R. Baechler, V. Mujica, X. Aqueveque, L. Ramos, A. Soto, Prevalence of diabetes mellitus in the Seventh Region of Chile, Rev. Med. Chil. 130 (11) (2002) 1257–1264.
[82] P. Aschner, H. King, M. de Torrado, B. Rodriguez, Glucose intolerance in Colombia, Diabetes Care 16 (1) (1993) 90–93.
[83] R. Wilks, C. Rotimi, F. Bennett, N. McFarlane-Anderson, J.S. Kaufman, S.G. Anderson, et al., Diabetes in the Caribbean: results of a population survey from Spanish Town, Jamaica, Diabet. Med. 16 (10) (1999) 875–883.
[84] A. Barcelo, M.C. Daroca, R. Ribera, E. Duarte, A. Zapata, M. Vohra, Diabetes in Bolivia, Rev. Panam Salud Publica 10 (5) (2001) 318–323.
[85] C.A. Aguilar-Salinas, O. Velazquez Monroy, F.J. Gomez-Perez, A. Gonzalez Chavez, A.L. Esqueda, V. MolinaCuevas, et al., Characteristics of patients with type 2 diabetes in Mexico: results from a large population-based nationwide survey, Diabetes Care 26 (7) (2003) 2021–2026.
[86] C.P. Sanchez-Castillo, O. Velasquez-Monroy, A. Lara-Esqueda, A. Berber, J. Sepulveda, R. Tapia-Conyer, et al., Diabetes and hypertension increases in a society with abdominal obesity: results of the Mexican National Health Survey 2000, Public Health Nutr. 8 (1) (2005) 53–60.
[87] A.S. Shera, G. Rafique, I.A. Khawaja, S. Baqai, H. King, Pakistan National Diabetes Survey: prevalence of glucose

intolerance and associated factors in Baluchistan province, Diabetes Res. Clin. Pract. 44 (1) (1999) 49–58.
[88] A.S. Shera, G. Rafique, I.A. Khwaja, J. Ara, S. Baqai, H. King, Pakistan National Diabetes survey: prevalence of glucose intolerance and associated factors in Shikarpur, Sindh Province, Diabet. Med. 12 (12) (1995) 1116–1121.
[89] A.S. Shera, G. Rafique, I.A. Khwaja, S. Baqai, I.A. Khan, H. King, et al., Pakistan National Diabetes Survey prevalence of glucose intolerance and associated factors in North West Frontier Province (NWFP) of Pakistan, J. Pak. Med. Assoc. 49 (9) (1999) 206–211.
[90] A. Basit, M.Z. Hydrie, K. Ahmed, R. Hakeem, Prevalence of diabetes, impaired fasting glucose and associated risk factors in a rural area of Baluchistan province according to new ADA criteria, J. Pak. Med. Assoc. 52 (8) (2002) 357–360.
[91] R. Malek, F. Belateche, S. Laouamri, M. Hamdi-Cherif, A. Touabti, W. Bendib, et al., Prevalence of type 2 diabetes mellitus and glucose intolerance in the Setif area (Algeria), Diabetes Metab. 27 (2 Pt 1) (2001) 164–171.
[92] W. Herman, M. Ali, R. Aubert, M. Engelgau, S. Kenny, E. Gunter, et al., Diabetes mellitus in Egypt: risk factors and prevalence, Diabet. Med. 12 (1995) 1126–1131.
[93] M. Arab, Epidemiology of diabetes mellitus in Egypt, Egypt. J. Diabetes 2 (1) (1997) 1–15.
[94] F. Azizi, P. Salehi, A. Etemadi, S. Zahedi-Asl, Prevalence of metabolic syndrome in an urban population: Tehran Lipid and Glucose Study, Diabetes Res. Clin. Pract. 61 (1) (2003) 29–37.
[95] K. Ajlouni, H. Jaddou, A. Batieha, Diabetes and impaired glucose tolerance in Jordan: prevalence and associated risk factors, J. Intern. Med. 244 (4) (1998) 317–323.
[96] H. King, B. Abdullaev, S. Djumaeva, V. Nikitin, L. Ashworth, M.G. Dobo, Glucose intolerance and associated factors in the Fergana Valley, Uzbekistan, Diabet. Med. 15 (12) (1998) 1052–1062.
[97] H. King, S. Djumaeva, B. Abdullaev, M. Gacic Dobo, Epidemiology of glucose intolerance and associated factors in Uzbekistan: a survey in Sirdaria province, Diabetes Res. Clin. Pract. 55 (1) (2002) 19–27.
[98] M.A. Tazi, S. Abir-Khalil, N. Chaouki, S. Cherqaoui, F. Lahmouz, J.E. Srairi, et al., Prevalence of the main cardiovascular risk factors in Morocco: results of a National Survey, 2000, J. Hypertens. 21 (5) (2003) 897–903.
[99] M. El-Hazmi, A. Warsy, A. Al-Swailem, A. Al-Swailem, R. Sulaimani, Diabetes mellitus as a health problem in Saudi Arabia, East. Mediter. Health J. 4 (1) (1998) 58–67.
[100] M.M. Al-Nozha, M.A. Al-Maatouq, Y.Y. Al-Mazrou, S.S. Al-Harthi, M.R. Arafah, M.Z. Khalil, et al., Diabetes mellitus in Saudi Arabia, Saudi Med. J. 25 (11) (2004) 1603–1610.
[101] A.R. Al-Nuaim, Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia, Diabet. Med. 14 (7) (1997) 595–602.
[102] M. Elbagir, M. Eltom, E. Elmahadi, I. Kadam, C. Berne, A population-based study of the prevalence of diabetes and impaired glucose tolerance in adults in Northern Sudan, Diabetes Care 19 (10) (1996) 1126–1128.
[103] R. Bouguerra, H. Alberti, L.B. Salem, C.B. Rayana, J.E. Atti, S. Gaigi, et al., The global diabetes pandemic: the Tunisian experience, Eur. J. Clin. Nutr. 61 (2) (2007) 160–165.
[104] M. Al-Habori, M. Al-Mamari, A. Al-Meeri, Type II diabetes mellitus and impaired glucose tolerance in Yemen: prevalence, associated metabolic changes and risk factors, Diabetes Res. Clin. Pract. 65 (3) (2004) 275–281.