Aim: To produce current estimates of the national, regional and global impact of diabetes for 2015 and 2040.

Methods: A systematic literature review was conducted to identify data sources on the prevalence of diabetes from studies conducted in the period from 1990 to 2015. An analytic hierarchy process was used to select the most appropriate studies for each country, and estimates for countries without data were modelled using extrapolation from similar countries that had available data. A logistic regression model was used to generate smoothed age-specific estimates, which were applied to UN population estimates.

Results: 540 data sources were reviewed, of which 196 sources from 111 countries were selected. In 2015 it was estimated that there were 415 million (uncertainty interval: 340–536 million) people with diabetes aged 20–79 years, 5.0 million deaths attributable to diabetes, and the total global health expenditure due to diabetes was estimated at 673 billion US dollars. Three quarters (75%) of those with diabetes were living in low- and middle-income countries. The number of people with diabetes aged 20–79 years was predicted to rise to 642 million (uncertainty interval: 521–829 million) by 2040.

Conclusion: Diabetes prevalence, deaths attributable to diabetes, and health expenditure due to diabetes continue to rise across the globe with important social, financial and health system implications.

1. Introduction

Diabetes mellitus describes a group of metabolic disorders characterised by increased blood glucose concentration. People living with diabetes have a higher risk of morbidity and mortality than the general population. The global prevalence of diabetes in adults has been increasing over recent decades. In 1964, it was estimated that 30 million people had diabetes [15]. Less than 40 years later, the WHO estimated that there were 171 million people living with diabetes [51]. The Inter-
national Diabetes Federation (IDF) estimated the global prevalence to be 151 million in 2000 [28], 194 million in 2003 [27], 246 million in 2006 [26], 285 million in 2009 [25], 366 million in 2011 [24], and 382 million in 2013 [23]. Each estimate was based on the latest data available. The IDF Atlas methodology was substantially updated in 2011 [19] to incorporate an analytic hierarchy process that formalised the methods to prioritise the highest quality data from available sources.

The dramatic increase in diabetes has occurred in all countries, and in rural as well as urban areas. Accurate global, regional, and country-level estimates and projections of diabetes prevalence are necessary for prevention and treatment strategies to be planned and monitored, and to assess progress towards reaching the targets set by the Global Action Plan for Non-Communicable Diseases and the Sustainable Development Goals [55].

This paper provides estimates of the worldwide and regional impact of diabetes for 2015 and 2040, based on the most recent and highest quality epidemiological data. For the first time, the IDF Diabetes Atlas methodology also includes uncertainty intervals to reflect confidence levels around the prevalence estimates. These uncertainty measurements permit the comparison of the IDF Diabetes Atlas estimates with other sources and over time.

2. Materials and methods

2.1. Study selection

A literature search of PubMed, Medline, and Google Scholar was conducted, without language restriction, to identify data sources providing the age-specific prevalence of diabetes from studies that were conducted from January 1990 to June 2015. 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”) were used. Additionally, data sources were gathered from national health surveys conducted by governments, or international organisations such as the World Health Organization (WHO). Relevant citations from published literature were also reviewed, and investigators within the IDF network were consulted to identify additional data sources. If the identified studies did not contain at least three age-groups for adults between 20 and 79 years, enquiries were sent to corresponding authors with a request to provide additional information.

Methodological information was extracted from studies. The studies were then classified according to the following criteria: method of diagnosis (e.g. fasting blood glucose, oral glucose tolerance tests, glycated haemoglobin (HbA1c), self-report, medical record, random blood glucose, glycosuria); 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); year of the survey; and type of publication (e.g. peer-reviewed publication, national health survey, STEPwise approach to Surveillance study, personal communication).

Studies were excluded if they 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 pharmacologically-treated diabetes, or were conducted before 1990. Studies reporting only the prevalence of type 1 diabetes, newly diagnosed diabetes, or with inconsistent results were also excluded.

A scoring system was developed using the analytic hierarchy process [43]. This allows different characteristics of a study to be compared and weighted to produce one objectively combined score that reflects the quality of each study. The analytic hierarchy process was used to compare different studies and decide on those that should be included, which enabled a quantifiable, reproducible, and transparent method of determining which study was selected and why.

The same approach was used as in the previous publications [19], however, the weights of each particular characteristic listed above were updated for 2015 (Supplementary Table 1). The updated weights were obtained by requesting members of the steering committee for the IDF Diabetes Atlas to complete preferences charts, and these preferences were used to assign a value for each pairwise comparison (e.g. age of the data source vs method of diagnosis). When there was disagreement among respondents, a median value was used. Those pairwise comparisons were then input into a comparison matrix and assigned a priority weight using matrix algebra. The new weights of each study characteristic were calculated on this base. A similar procedure was used to assess the quality of studies that reported undiagnosed diabetes prevalence.

Using the analytic hierarchical process, each study was given a score, with higher scores indicating better quality. A stepwise threshold sensitivity analysis was conducted to find the optimal lowest selection threshold. The value of 0.32 resulted in the most conservative global estimate of diabetes prevalence, and was thus selected. Thresholds higher or lower than 0.32 resulted in less conservative global estimates of diabetes prevalence [36]. Data sources scoring below this threshold of 0.32 were rejected. Among the studies with an analytic hierarchy process score greater than 0.32, the highest scoring study for each country was selected. If there were any other studies that had a score that was greater than 0.32 and was within the tolerance level (0.1) of the highest scoring study, that study was also selected.

In countries where more than one study was selected, the age-specific prevalence of diabetes was calculated as the weighted average of the contributing studies, with each study’s contribution being weighted by its quality score from the analytic hierarchy process.

If no suitable studies were available for a country or territory, estimates were based on available data from countries matched by geographic location, World Bank income group, language, ethnicity, and IDF Region. Income groups were taken from the updated World Bank’s 2015 classification of the world’s economies [52] into four groups (low-income countries; lower middle-income countries; upper middle-income countries; and high-income countries) based on estimates of gross national income per capita for the previous calendar year. Data on languages and ethnicities were derived.
Analyses were conducted using the R statistical program version 3.1.0 [39]. The age- and sex-specific prevalence of diabetes was calculated for urban and rural settings for each country [35]. Logistic regression was used to generate smoothed sex- and age-specific prevalence estimates for adults 20–79 years after data were extracted. The regression used age (as midpoint of each age-group) and the quadratic of age as separate independent variables for each sub-group (sex- and urban/rural setting-related) if available. The quadratic term was included to allow for a drop in diabetes prevalence for the oldest age groups. For some sources, where a sample size in a single group was less than 50, point adjustments were made by combining age groups to reduce variability.

Where primary data were not stratified by urban and rural status, a ratio was applied to estimate the proportion of diabetes for each setting, which was derived from aggregated data available within one IDF region together with the percentage urbanisation by country available from the UN Population Division Urbanization Prospects. [47]. For high income countries, the urban to rural ratio was assumed to be 1.0.

Undiagnosed diabetes cases and estimated ratios of the proportion of undiagnosed cases to the total number of cases were also collected from the data source, if this information was available. This estimation procedure also included a data source selection procedure where appropriate studies were chosen using the analytic hierarchy process, similar to the methods described above.

In previous editions of the IDF Diabetes Atlas [19], for those studies not reporting undiagnosed diabetes, this was estimated using the median proportion of people with undiagnosed diabetes from all studies within the same IDF Region that did report undiagnosed diabetes. For 2015, the IDF regional-level and World Bank income group-level effects on undiagnosed diabetes were estimated by random-effect generalised linear regression, with weights corresponding to the quality score of the studies. The country-specific effect was generally assumed to be unknown and driven by latent variables to control for unobserved heterogeneity. The Durbin-Watson statistic was used to detect the presence of autocorrelation and check if the model was appropriate. The IDF Region and World Bank income group characteristics had a significant association with the proportion of people with undiagnosed diabetes at a country level. The final model estimated undiagnosed diabetes by using studies from that country (if applicable), as well as studies from countries within the same IDF Region and World Bank income group, with weights corresponding to the quality score of the study [34].

As these figures are only estimates, uncertainty intervals were introduced to reflect the range in which the “true” prevalence of diabetes is likely to lie, with a 95% probability. To estimate the potential sources of uncertainty in the prevalence estimates and their magnitude, two separate analyses were performed: (1) a simulation study to assess raw data uncertainty, where 500 random samples were drawn inside of the 95% confidence interval range for each raw point estimate given in the data sources. These samples were then used in the IDF estimation procedure as conducted for the original data. (2) A bootstrap analysis of the sensitivity of the global prevalence estimate to the study selection process. In a loop, one of all the selected studies was randomly picked up and removed from the list; the global prevalence was calculated on a base of remaining studies. Wider uncertainty intervals indicated that the estimates were based on less reliable data sources [37].

The calculated age-, sex- and setting-specific estimates were then multiplied by corresponding population estimates for 2015, published by the United Nations [46] for each of the 220 countries and territories to generate estimates of cases of diabetes in adults aged 20–79 years. To predict the number of people with diabetes for 2040, the middle 2040 population projections from the United Nations Population Division were used [46]. The 2040 diabetes prevalence projections accounted for changes in population age structure and urbanisation, but did not explicitly include changes in the prevalence of any other diabetes risk factors.

Two different prevalence estimates were produced for each country and region: country-standardised and world-standardised prevalence. Country-standardised prevalence was calculated by standardising the prevalence to the age and sex distribution of the relevant country. This measurement provides the most useful way of assessing the impact of diabetes for each country or region. However, because the prevalence of diabetes increases with age, it cannot be used for comparing risk of diabetes between countries or regions which have different age structures. World-standardised prevalence estimates were produced by standardising each country’s prevalence to the same 2001 WHO Standard Population [2]. This removed the differences of age structures between countries and regions, and made this measurement suitable for making comparisons.

The number of people with diabetes for each of the seven IDF Regions and World Bank income group 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 number of cases of diabetes for each country.

The same methodology was employed for impaired glucose tolerance estimates for 2015 and 2040. Estimates for hyperglycaemia in pregnancy and gestational diabetes were based on methodology previously described [30].

2.3. Diabetes health expenditure estimates

The estimates of total health expenditures on diabetes, and the mean health expenditures per person with diabetes expressed in both US Dollars (USD) and International Dollars (ID) were calculated using methodology previously described from the Central Intelligence Agency World Factbook [10]. The seven IDF Regions (Africa; Europe; Middle East and North Africa; North America and the Caribbean; South and Central America; South-East Asia; and the Western Pacific) were based on the six WHO Member States groups where the Americas WHO region is divided into two parts: North America and Caribbean Region and South and Central America Region.
This method assumes that the health expenditure for people with diabetes is, on average, twice the health expenditure for people without diabetes.

2.4. Diabetes mortality estimates

The number of deaths due to diabetes was also updated for each UN ratified country. The methods to derive these estimates have been previously described [22,41]. Briefly, the number of deaths attributable to diabetes used the following inputs: WHO life tables for 2010 for the expected number of deaths; country-specific diabetes prevalence by age and sex for the year 2015; age- and sex-specific relative risks of death for persons with diabetes compared to those without diabetes. These inputs were used to model the estimates using DisMod II, a program developed for the Global Burden of Disease study from 2000 and then Miettinen’s formula for the population-attributable fraction was used to calculate the number of deaths attributable to diabetes in people who aged 20–79 years.

3. Results

3.1. Study selection

The analytic hierarchy process ranked the most important study characteristics as (1) sample representation (nationally representative scoring most highly, followed by regionally representative), (2) diagnostic criteria (oral glucose tolerance test scoring most highly), (3) sample size (5000 people or more scoring most highly), and (4) age of study (less than 5 years old scoring most highly) (Supplementary Table 1).

The literature search identified 540 data sources from 154 countries. Of these, 196 data sources were selected based on the analytic hierarchy process, representing 111 countries. The majority of data sources (178 out of 196) were nationally representative. All studies in the selected list were population-based, although only 62 used the oral glucose tolerance test as a method of diagnosis. The complete list of data sources selected to produce the estimates can be found at www.diabetesatlas.org.

The South-East Asia Region had original data sources from the highest proportion of countries (86%) within the region. Original data sources were available from 76% of countries in the Middle East and North Africa Region, 62% in the Western Pacific Region, 59% of countries in the Europe Region, 45% in the South and Central America Region, and 39% in the North America and Caribbean Region. The Africa Region had the lowest proportion of countries with original data sources, at only 24%.

Although there was an increase in the number of data sources providing information of diabetes prevalence, and with 144 out of 173 studies being nationally-representative, there remained a shortage of high quality studies in 95 countries around the world. For example, in the Africa Region and the North America and Caribbean Region, less than half of countries were represented by original data. Even though 59% of countries in the Europe Region were represented by population-based studies, only 14% of countries had studies that used oral glucose tolerance tests.

3.2. Prevalence estimates of diabetes, impaired glucose tolerance, and hyperglycaemia in pregnancy

These data sources were used to produce an estimate of 415 million cases (uncertainty interval: 340–536 million) of diabetes among adults aged 20–79 years in 220 countries and territories for 2015. For 2040, it was estimated that 642 million (uncertainty interval: 521–829 million) people aged 20–79 will have diabetes (Table 1). Detailed estimates for each of the 220 countries and territories can be found online at www.diabetesatlas.org and in Supplementary Table 2.

| Table 1 – Global estimates of diabetes prevalence, mortality, health expenditure, impaired glucose tolerance prevalence and hyperglycaemia in pregnancy prevalence for 2015 and 2040. NC = Not calculated. |
|---------------------------------------------------|-----------|-----------|
| General population |
| Total world population | 7.3 billion | 9.0 billion |
| Adult population (20–79 years) | 4.7 billion | 6.2 billion |
| Total live births to women aged 20–49 years | 129.4 million | NC |
| Diabetes (20–79 years) |
| Global prevalence (uncertainty interval) | 8.8% (7.2–11.4%) | 10.4% (8.5–13.5%) |
| Number of people with diabetes (uncertainty interval) | 415 million (340–536 million) | 642 million (521–829 million) |
| Number of deaths due to diabetes | 5.0 million | NC |
| Health expenditure due to diabetes (20–79 years) |
| Total health expenditure, 2015 USD | 673 billion | 802 billion |
| Impaired glucose tolerance (20–79 years) |
| Global prevalence (uncertainty interval) | 6.7% (4.5–12.1%) | 7.8% (5.2–13.9%) |
| Number of people with impaired glucose tolerance | 318 million (212–572 million) | 481 million (317–856 million) |
| Hyperglycaemia in pregnancy (20–49 years) |
| Global prevalence | 16.2% of live births | NC |
| Number of live births affected | 20.9 million | NC |
| Proportion of hyperglycaemia in pregnancy cases due to gestational diabetes | 85.1% | NC |
The global diabetes prevalence in adults aged 20–79 years was estimated at 8.8% (uncertainty interval: 7.2–11.3%). There were differences in the prevalence of diabetes by age group, World Bank income group, and geographical region. Diabetes prevalence was higher in high- and middle-income countries compared to low-income countries (Fig. 1a). Three quarters (75%) of people with diabetes were estimated to be living in low- and middle-income countries (data not shown). Diabetes prevalence peaked at ages 65–69 years for men and ages 75–79 years for women (Fig. 1b). The prevalence in people aged 80 years and over was not calculated. The highest world-standardised diabetes prevalence was in the North American and Caribbean Region (11.5%, uncertainty interval: 9.5–13.0%). The lowest world-standardised prevalence of diabetes in adults was in the Africa Region (3.8%, uncertainty interval: 2.6–7.9%) (Fig. 1c). The largest number of people with diabetes (153.2 million, uncertainty interval: 135.3–187.7 million) was found in the Western Pacific Region. Over half (56%) of all people with diabetes were living in the South-East Asia Region or the Western Pacific Region in 2015 (Fig. 1d). The regions that are projected to experience the highest growth rates in the number of people with diabetes are the Africa Region (140.7% increase by 2040) and the Middle East and North Africa Region (103.8% increase by 2040) (Fig. 1d).

Only half of all data sources (94 out of 196) reported undiagnosed diabetes. Using these data, and extrapolating to the countries not reporting undiagnosed diabetes, it is estimated that, globally, 46.5% of adults aged 20–79 years with diabetes were undiagnosed in 2015 (Table 2). The Africa region had the highest percentage of undiagnosed diabetes, at an estimated 66.7% of all cases of diabetes in the region. It was also estimated that over 50% of adults with diabetes in the South East Asia and Western Pacific Regions were undiagnosed (Table 2). The lowest estimated proportion of people with diabetes...
undiagnosed diabetes was in the North America and Caribbean Region (21.4%), however this estimate was based largely on estimates from Canada and the USA. Estimates from Belize, Haiti, Mexico, USA and the US Virgin Islands were derived from studies using oral glucose tolerance tests. There were very few data sources on the proportion of people with undiagnosed diabetes in the Caribbean.

It was estimated that there were 318 million (uncertainty interval: 212–572 million) adults aged 20–79 years with impaired glucose tolerance in 2015 (Table 1). In 2015, approximately 20.9 million births (16.2% of all live births from mothers aged 20–49 years) were affected by hyperglycaemia in pregnancy (Table 1). Approximately 17.8 million of these births were affected by gestational diabetes.

### 3.3. Diabetes health expenditure estimates

Total global health expenditure due to diabetes was estimated at 673 billion US dollars for 2015 and 802 billion US dollars for 2040. Approximately 12% of global health expenditure was estimated to be dedicated to diabetes, and the mean health expenditure per person with diabetes was 1917 International Dollars. The highest proportion of health dollars spent on diabetes was in middle-income countries (12.5%), while the lowest proportion was spent in low-income countries (5.9%). The proportion of health expenditure spent on diabetes in high-income countries was 11.4% (Fig. 2a). Men aged 60–69 years were the population group responsible for the largest spending on diabetes (102 billion US dollars) (Fig. 2b). In terms of IDF regions, the Middle East and North Africa Region spent the highest proportion of health expenditure on diabetes (15.2%), while the Africa Region spent the lowest proportion (7.0%) (Fig. 2c). While the number of people with diabetes is expected to grow by 54.7% between 2015 and 2040, the global health expenditure on diabetes is only expected to increase by 25.4% (Fig. 2d), because a large proportion of total health expenditure occurs in high-income countries, but most of the growth in diabetes is projected to occur in low- and middle-income countries.

### 3.4. Diabetes mortality estimates

In 2015, it was estimated that there were 5.0 million deaths attributable to diabetes in people aged 20–79 years. Diabetes accounted for 12.8% of global all-cause mortality among people aged 20–79 (data not shown). Over 4 million diabetes-attributable deaths in people aged 20–79 occurred in low- and middle-income countries (Fig. 3a). The population group with the highest proportion of deaths from diabetes was women aged 50–59 years, accounting for 20% of all-cause mortality in that group (Fig. 3b). The region with the highest proportion of deaths from diabetes was the Western Pacific Region, accounting for approximately 16% of all-cause mortality in the region (Fig. 3c). Three quarters (75.5%) of all diabetes deaths occurred in people aged 69 years and under (Fig. 3d). In low-income countries, 72.7% of diabetes deaths were in people under the age of 60, whereas this proportion in high-income countries was 29.6%.

### 4. Discussion

A systematic literature review identified 540 studies on the prevalence of diabetes conducted between the period of 1990 and 2015. Using an analytic hierarchy process, 196 sources from 111 countries were selected. Using extrapolation, logistic regression, and UN population estimates, it was estimated that in 2015 there were 415 million (uncertainty interval: 340–536 million) people with diabetes aged 20–79 years, 5.0 million deaths attributable to diabetes, and a total global health expenditure due to diabetes of 673 billion US dollars. The number of people with diabetes aged 20–79 years was predicted to rise to 642 million (uncertainty interval: 521–829 million) by 2040.

#### 4.1. Study selection

Three main characteristics affect the accuracy of the estimates: the availability of data, the quality of data, and the representativeness of the data sources chosen. There was a large variation in methods and standards of the data sources. The data sources used in the model had substantial differences in diagnostic methods, the age of study, sample size of the study, and type of data source. Despite efforts to select the highest quality studies for each country using the analytic hierarchy process, and to standardise estimates using logistic regression, it was still difficult to minimise the differences in country-level estimates that were due to methodological
diversity. Thus, the variation in methods and standards are likely to have influenced the degree to which the estimates can be depended on to be accurate, and should be taken into account when making comparisons between countries. If newer data based on reliable measurements from well-conducted studies becomes available, future estimates of diabetes prevalence will become more accurate [32].

4.2. Prevalence estimates of diabetes, impaired glucose tolerance, and hyperglycaemia in pregnancy

The 2040 projections may be considered conservative because they do not account for the changes in global obesity rates or other diabetes risk factors. There are many population-level diabetes risk factors that were not incorporated into the model, such as ethnicity [42], overweight [29], highest level of household education [40], household income [40], food security [40], sugar availability [4], percent of total energy intake from sugars and sweeteners [44], impaired glucose tolerance [38], gestational diabetes [29], and other non-communicable diseases [38]. Changes in any of these risk factors over the next 25 years will influence the accuracy of the 2040 projections.

It was not possible to estimate the number of adults with type 1 and type 2 diabetes separately, as most of the studies used did not report these groups independently. In high-income countries, a few studies [7,8,16,21] have estimated that approximately 87–91% of all people with diabetes have type 2 diabetes, 7–12% have type 1 diabetes, and 1–3% have other types of diabetes. The relative proportions of type 1 and type 2 diabetes have not been reported in sufficient detail in low- and middle-income countries.

Uncertainty intervals were estimated using a mixed method by combining the raw data uncertainty and the model's sensitivity to data source selection. The 95% uncertainty interval around the "true" global prevalence of diabetes was estimated at between 7.2% and 11.4% of the adult population (age range 20–79 years). Within this interval lies the diabetes prevalence estimate of 8.5% (age range 18–100+), produced by the WHO in 2016 [53]. However, by using only this "one-
...at-a-time” sensitivity to estimate uncertainty, the approach did not take into account any other potential sources of uncertainty. Other researchers have produced credible intervals using 2.5% and 97.5% percentiles of the posterior distributions of diabetes prevalence produced from a Bayesian model (NCD Risk Factor Collaboration (NCD-RisC) [33]).

The large proportion of people with undiagnosed diabetes means that there are many people worldwide living with high blood glucose, which puts them at high risk of complications such as diabetic retinopathy and cardiovascular disease. Screening high-risk populations for diabetes will help identify those currently undiagnosed, enabling treatment to be initiated to reduce the risk of further morbidity. Several regionally-validated risk assessment tools for type 2 diabetes have been developed for this purpose [9,17,18,45].

Such tools can also help identify those with impaired glucose tolerance. People with impaired glucose tolerance are at increased risk of diabetes, kidney disease, cardiovascular disease, and all-cause mortality [50]. In some populations, lifestyle interventions to prevent or delay progression to type 2 diabetes may be a cost-effective strategy to decrease the risk of mortality and morbidity in people with impaired glucose tolerance [20]. Gestational diabetes is also a risk factor in both the mother and child for later development of type 2 diabetes [6,11] and is thus a potent trans-generational driver of increased incidence of diabetes.

### 4.3. Diabetes health expenditure estimates

The major driver of diabetes costs is the treatment of the related complications. In the USA, hospital inpatient care was responsible for 43% of the total medical cost, and medication to treat complications accounted for 18% of the total medical cost of diabetes [3]. In the United Kingdom, it was estimated that 80% of total diabetes costs were spent on treating complications [14]. Investing in intensive blood glucose control could help to reduce the cost of diabetes complications by up to 32% [13]. Furthermore, in the United Kingdom alone it was estimated that improved diabetes management could lead to savings of £340 million in the first five years [5].

### 4.4. Diabetes mortality estimates

The World Health Organisation estimated that 1.5 million deaths were directly caused by diabetes in 2012 [56]. The World Health Organisation’s approach for estimating cause-specific mortality was based on statistics obtained from death certificates and reflects reported direct causes of death. The attributable-risk approach used in the IDF Diabetes Atlas allowed a more realistic estimate of the burden of mortality attributable to diabetes, but, at the same time, was based on a set of assumptions. For example, the age- and sex-specific relative risks of mortality in people with diabetes compared to
those without were extracted from a small number of studies and findings were applied to other disparate populations. Also, other covariates such as rural or urban environment, time since diagnosis, or medications were not applied in the model [22].

In low-income countries, 73% of diabetes deaths occurred in people under the age of 60. This high proportion of working-age people dying from diabetes in low-income countries is likely to have a substantial impact on economic development. Risk factors for mortality in people with diabetes include cardiovascular disease [48], kidney disease [1], depression [49], and high levels of HbA1c [31].

The 5.0 million estimated diabetes-attributable deaths estimated to have occurred in 2015 is higher than the combined number of annual deaths from HIV/AIDS (1.2 million), tuberculosis (1.5 million) and malaria (0.4 million) [54].

5. Conclusion

The prevalence of diabetes in adults aged 20–79 years was estimated to be 8.8% in 2015 and predicted to rise to 10.4% in 2040. The high prevalence of diabetes in adults has important social, financial and development implications. There is an increasingly urgent need for governments to implement policies to decrease the risk factors for type 2 diabetes and gestational diabetes, and ensure appropriate access to treatment for all people living with diabetes. Tackling the global impact of diabetes is a monumental task and the IDF continues to act as an advocate for people with diabetes, by educating both individuals and governments on the steps that can be taken for prevention and management of the disease.

Conflicts of interest

KO, JdDRF, YH, UL, LG, DC and LEM are current or former employees of the International Diabetes Federation, which has received funding from AstraZeneca, Bayer HealthCare, BD, Boehringer Ingelheim, Lilly Diabetes, Medtronic, Merck Sharp and Dohme, Novartis, Novo Nordisk, Sanofi Diabetes, Servier, and Takeda. JES has received honoraria for talks and consultancy from Astra Zeneca, Takeda, Merck Sharp and Dohme, Novartis, Eli Lilly, Bristol-Myers Squibb, Novo Nordisk, and Sanofi-Aventis. LEM has received honoraria for talks from Bayer HealthCare. DC has received honoraria for consultancy from Roche Diabetes Care.

Contributions

KO and JdDRF contributed to the study conception and design, acquisition of data, analysis and interpretation of data, drafting and critical revision of the manuscript. YH contributed to the analysis and interpretation of data, drafting and critical revision of the manuscript. UL and LG contributed to the study conception and design, acquisition of data, and critical revision of the manuscript. NHC contributed to the study conception and design, and critical revision of the manuscript. DC contributed to the study conception and design, analysis and interpretation of data, drafting and critical revision of the manuscript. LEM contributed to the study conception and design, acquisition of data, analysis and interpretation of data, drafting and critical revision of the manuscript. KO and LEM are the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.diabres.2017.03.024.

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