**Worldwide trends in diabetes since 1980: pooled analysis of 751 population-based measurement studies with over 4.4 million participants**

NCD Risk Factor Collaboration (NCD-RisC)

**Summary**

**Background:** One of the global targets on non-communicable diseases is to halt, by 2025, the rise in the age-standardised adult prevalence of diabetes compared to its 2010 levels. There is limited information on how the prevalence of diabetes has changed globally, how likely it is for countries to achieve the global target, and how changes in prevalence, together with population growth and ageing, are affecting the number of people with diabetes.

**Methods:** We pooled 751 population-based measurement studies conducted from 1980 to 2014, with over 4.4 million participants aged 18 years and older. We used a Bayesian hierarchical model to estimate trends in the prevalence of diabetes, defined as fasting plasma glucose ≥7.0 mmol/L or history of diagnosis with diabetes or using insulin or oral hypoglycaemic drugs, in 200 countries and territories in 21 regions. We calculated the posterior probability of meeting the global diabetes target, if post-2000 trends continue.

**Findings:** Age-standardised adult diabetes prevalence in the world increased from 4.3% (95% credible interval 2.4-7.0) in 1980 to 9.0% (7.2-11.1) in 2014 in men and from 5.0% (2.9-7.9) to 7.9% (6.4-9.7) in women. The number of adults with diabetes in the world increased from 108 million in 1980 to 422 million in 2014, with contributions of 28% from the rise in prevalence, 40% from population growth and ageing, and 32% from the interaction of these two factors. Age-standardised adult diabetes prevalence in 2014 was lowest in North Western Europe, and highest in Polynesia and Micronesia, at nearly 25%, followed by Melanesia and the Middle East and North Africa. From 1980 to 2014, there was virtually no change in age-standardised diabetes prevalence among adult women in continental Western Europe, although crude prevalence rose due to ageing of the population. In contrast, age-standardised adult prevalence rose by 15 percentage points in men and women in Polynesia and Micronesia. In 2014, American Samoa had the highest national prevalence of diabetes (>30% in both sexes) with age-standardised adult prevalence also >25% in a few other islands in Polynesia and Micronesia. If post-2000 trends continue, the probability of meeting the global target of halting the rise in the prevalence of diabetes by 2025 at the 2010 level is <1% for men and 1% for women in the world as a whole. Only men in nine countries and women in 29 countries, mostly in Western Europe, have a 50% or more probability of meeting the global target.

**Interpretation:** Since 1980, age-standardised diabetes prevalence in adults increased or at best remained unchanged in every country. Together with population growth and ageing, this rise has led to a quadrupling of the number of people with diabetes in the world. The burden of diabetes, in terms of both prevalence and number of people, has increased faster in low- and middle-income countries than in high-income countries.

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**Introduction**

Diabetes is an important cause of mortality, morbidity, and health systems costs in the world.[1](#_ENREF_1),[2](#_ENREF_2) Therefore, there is an urgent need to implement population-based interventions that prevent diabetes, enhance its early detection, and use lifestyle and pharmacological interventions to prevent or delay its progression to complications. To further motivate such actions, one of the global targets set after the 2011 United Nations High-Level Meeting on Non-Communicable Diseases (NCDs) is to halt, by 2025, the rise in the age-standardised adult prevalence of diabetes at its 2010 levels.[3](#_ENREF_3) Valid and consistent estimates of diabetes prevalence over time are needed to evaluate the impacts of interventions, conduct international comparisons of trends, and measure progress towards the agreed target.

A previous study estimated trends in mean fasting plasma glucose (FPG) from 1980 to 2008 and also reported diabetes prevalence, but only as a secondary outcome and estimated based on mean FPG.[4](#_ENREF_4) The International Diabetes Federation (IDF) periodically reports diabetes prevalence (see panel),[5](#_ENREF_5),[6](#_ENREF_6) but does not analyse trends, uses some sources that are solely based on self-reported diabetes, and does not fully account for differences in diabetes definitions in different data sources,[7](#_ENREF_7) even though diabetes prevalence varies depending on whether it is defined based on FPG, 2-hour plasma glucose in an oral glucose tolerance test (2hOGTT), or haemoglobin A1c (HbA1c).[8](#_ENREF_8) Further, it is not known how trends in prevalence together with population growth and ageing have affected the number of people with diabetes. Our aim was to estimate worldwide trends in the prevalence and number of people with diabetes. We also estimated the probability of achieving the global diabetes target.

**Methods**

*Overview*

We estimated trends in diabetes prevalence – defined as FPG ≥7.0 mmol/L or history of diagnosis with diabetes or using insulin or oral hypoglycaemic drugs – from 1980 to 2014 in 200 countries and territories organised into 21 regions, based on geography and epidemiological similarity (Appendix Table 1). This definition of diabetes is used in the Global Monitoring Framework for NCDs;[3](#_ENREF_3) it also relies more directly on data from population-based health examination surveys which are more likely to measure FPG than 2hOGTT for logistical reasons. Our analysis covered men and women 18 years of age and older, consistent with the Global Monitoring Framework for NCDs.[3](#_ENREF_3)

Our study had three steps, each described in detail below and in the Appendix. First, we identified, accessed, and re-analysed population-based health examination surveys with measured data on diabetes. We then converted diabetes prevalence in those sources that had defined diabetes based on 2hOGTT or HbA1c, or had reported an FPG-based definition using a cut-off other than 7.0 mmol/L, to prevalence based on the above primary definition. Finally, we applied a statistical model to the pooled data to estimate trends for all countries and years.

*Data sources*

We included data sources that were representative of a national, sub-national, or community population and had measured at least one of the following diabetes biomarkers: FPG, 2hOGTT and HbA1c. We did not use data from sources that did not measure biomarkers and relied entirely on self-reported history of diagnosis because this approach would miss undiagnosed diabetes, which forms a substantial share of all people with diabetes, especially where healthcare access is limited.[9-11](#_ENREF_9) Our methods for identifying and accessing data sources are described in the Appendix.

History of diabetes diagnosis was established with survey-specific questions, such as “have you ever been told by a doctor or other health professional that you have diabetes?” or the combination of “do you now have, or have you ever had diabetes?” and “were you told by a doctor that you had diabetes?”. Similarly, the use of diabetes medication was established with survey-specific questions, such as “Are you currently taking medication for diabetes or high blood sugar?” or the combination of “Do you currently inject insulin for diabetes?” and “Are you currently taking any medicines, tablets or pills for diabetes”. Some surveys had also verified medications with use of visual inspection and/or medical records, or used this approach for establishing the use of diabetes medicines.

*Conversion to a consistent definition of diabetes*

9% of our data were from sources that had reported the prevalence of diabetes based on 2hOGTT or HbA1c but not FPG. Another 29% of data were from a previous global pooling or extracted from published reports and papers, and had used FPG but reported only mean FPG or an FPG-based diabetes prevalence using a cut-off other than 7.0 mmol/L, e.g. diabetes defined as FPG ≥7.8 mmol/L. To correct for incomparability in definition of diabetes, we used regressions that converted prevalence from these sources to our primary outcome. The dependent variable in each of these regressions, which are described in detail elsewhere[8](#_ENREF_8) and presented in the Appendix, was the primary outcome (prevalence of FPG ≥7.0 mmol/L or history of diabetes diagnosis or use of diabetes medication), and the main independent variable was a prevalence based on the definitions in at least one study which did not report the primary outcome but had some form of data on diabetes and glycaemia. The coefficients of these regressions were estimated from data sources with individual-level data which could be used to calculate prevalence using both definitions. Details of conversion (or “cross-walking”) regressions, and their specification and coefficients, are presented in the Appendix. Data points based on fewer than 25 subjects were excluded. All regressions included terms for age, sex, country’s income (natural logarithm of per-capita gross domestic product adjusted for purchasing power and inflation), and the year of study. When more than 400 data points were used to estimate the regression coefficients, the regressions also included regional random effects. Finally, we included interaction terms in the regressions if the interaction terms provided a better fit to the data as determined by the Bayesian Information Criteria (BIC).

*Statistical methods*

The statistical model used to estimate diabetes prevalence by country, year, and age is described in detail in a statistical paper and in related substantive papers.[12-14](#_ENREF_12) In summary, the model had a hierarchical structure in which diabetes levels and trends in countries were nested in regional levels and trends, with use of random intercepts and slopes, which were in turn nested in those of “super-regions” and the globe. In this structure, estimates of diabetes levels and trends for each country and year were informed by its own data, if available, and by data from other years in the same country and in other countries, especially those in the same region, with data for similar time periods. The hierarchical structure borrows information to a greater degree when data are non-existent or weakly informative (e.g. because they have a small sample size or are not national), and to a lesser extent in data-rich countries and regions.

The model incorporated nonlinear time trends and age patterns. It allowed the age pattern of diabetes to vary across populations and the rise in prevalence with age to be steeper where diabetes prevalence is higher.[15](#_ENREF_15) The model accounted for the fact that prevalence in sub-national and community studies might systematically differ from nationally representative surveys, and also tend to have larger variation relative to the true values than national studies. These features were implemented by including data-driven fixed-effect and random-effect terms for sub-national and community data. The fixed effects adjust for systematic differences between sub-national or community studies and national ones. The random effects allow national data to have larger influence on the estimates than sub-national or community data with similar sample sizes. The model also accounted for rural-urban differences in diabetes prevalence, through the use of data-driven fixed effects for rural-only and urban-only studies. These rural and urban effects were weighted by the difference between study-level and country-level urbanisation. The statistical model included covariates that help predict diabetes prevalence, including average number of years of education, proportion of national population living in urban areas, a summary measure of availability of different food types for human consumption, and age-standardised adult mean body mass index (BMI).[16](#_ENREF_16) The covariate on food availability was constructed from the food balance sheets of the Food and Agriculture Organization of the United Nations, with use of principal component analysis. Details of the variables, data and methods are provided elsewhere, and in the Appendix of a prior paper.[13](#_ENREF_13),[17](#_ENREF_17)

We fitted this Bayesian model with the Markov chain Monte Carlo (MCMC) algorithm. Convergence was monitored and 5,000 post-burn-in samples were obtained from the (posterior) distribution of model parameters, which were in turn used to obtain the posterior distributions of diabetes prevalence. The reported credible intervals (CrI) represent the 2.5th-97.5th percentiles of the posterior distributions.

We estimated average relative change in prevalence over the 35 years of analysis. We also report the posterior probability (PP) that an estimated increase or decrease represents a truly increasing or decreasing trend. PP would be 0.50 in a country or region in which an increase is statistically indistinguishable from a decrease; a larger PP indicates more certainty in an increase and a smaller PP indicates more certainty in a decrease. In addition we calculated the PP of meeting the global target of no rise in diabetes prevalence if post-2000 trends continue. All analyses were done separately by sex. We used the WHO standard population for age standardisation.

As described in detail in the Appendix, we examined how well our model estimates diabetes prevalence in countries and years without data by withholding some of the data from the model, and calculating the differences between the held-out data and the estimates, i.e. the error in estimates. This validation test shows that our model performed quite well; the median errors were globally very close to zero, and the median absolute errors were small (Appendix Table 5).

*Role of funding source*

The funder of the study had no role in study design, data collection, analysis, interpretation, or writing of the report. Country and Regional Data Group members, BZ, JB and MDC had full access to the data in the study and the corresponding author had final responsibility for the decision to submit for publication.

**Results**

*Data sources*

Our data came from 751 population-based measurement surveys and studies, with >4.4 million participants aged 18 years and older. They covered 146 of the 200 countries and territories for which estimates were made. These 146 countries covered 90% of the world’s adult population in 2014 (Appendix Figure 2). Regionally, there were between an average of <1 data source per country in Central Africa to 24 sources per country in high-income Asia Pacific region. 21 of the 54 countries without data were in sub-Saharan Africa, 11 in the Caribbean, 7 in Eastern Europe, 4 in Central Asia and the remaining 11 in other regions. Nearly one third of data sources (242) were from years before 1995 and the other two thirds (509) for 1995 and later.

*Global and regional trends*

Age-standardised adult diabetes prevalence in the world increased from 4.3% (95% CrI 2.4-7.0) in 1980 to 9.0% (7.2-11.1) in 2014 in men and from 5.0% (2.9-7.9) to 7.9% (6.4-9.7) in women (Figure 1); the PPs that these were true increases were 0.993 and 0.947, respectively. Crude adult prevalence increased from 3.6% (2.0-5.9) to 8.8% (7.0-10.8) in men, and from 4.6% (2.7-7.4) to 8.2% (6.6-9.9) in women.

Age-standardised diabetes prevalence among adult women in 2014 was lowest in North and South Western Europe, both <5%. The lowest prevalence in adult men also occurred in North Western Europe, at 5.8% (3.6-8.7). Crude adult prevalence in North Western Europe was 5.9% (3.8-8.6) for women and 7.9% (5.1-11.5) for men. At the other extreme, age-standardised diabetes prevalence was >20% among adult men and women in Polynesia and Micronesia, and around 15% in Melanesia and in Middle East and North Africa. Over the 35 years of analysis, there was virtually no change in age-standardised diabetes prevalence among adult women in North Western Europe and South Western Europe, and there was only a small non-significant increase in Central and Eastern Europe. Adult men in North Western Europe also experienced a small rise relative to other regions. In contrast, age-standardised prevalence in Polynesia and Micronesia rose by 15.0 (5.5-25.9) percentage points in adult men (PP of being a true increase > 0.999) and by 14.9 (4.5-26.2) percentage points in adult women (PP = 0.998). Crude adult prevalence increased more than age-standardised prevalence where there was significant ageing, especially in high-income regions.

*National prevalences and trends*

In 1980, age-standardised adult diabetes prevalence had been <3% among men in 32 countries and women in 23 countries (Figure 2). In the same year, age-standardised prevalence was >12% in adult men and women in a few islands in Polynesia and Micronesia and women in Kuwait, reaching 25% in men and women in Nauru. By 2014, only women in 9 countries had an age-standardised adult prevalence <4%, with the lowest prevalences seen in some North Western European countries such as Switzerland, Austria, Denmark, Belgium and the Netherlands. In the same year, age-standardised prevalence among adult men was >4% in every country, with the lowest prevalences estimated in the same North Western European countries as women and in a few countries in East Africa and Southeast Asia. At the other extreme, age-standardised adult diabetes prevalence in 2014 was 31% (19-44) in men and 33% (21-47) in women in American Samoa, and was also >25% in men and women in a number of other islands in Polynesia and Micronesia.

No country achieved a statistically significant decrease in diabetes prevalence over the analysis period (Figure 3), although the relative increase over these 35 years was <20% in 9 countries for men, mostly in North Western Europe, and in 39 countries for women. Over the same period, age-standardised adult prevalence of diabetes at least doubled among men in 120 countries and among women in 87 countries, with a PP of being a true increase ~0.89 or higher. The largest absolute increases in age-standardised adult prevalence occurred in Oceania, exceeding 15 percentage points in some countries, followed by the Middle East and North Africa.

In the world as a whole, if post-2000 trends continue, the probability of meeting the global diabetes target is <1% for men and 1% for women. Only 9 countries, mostly in Western Europe, have a ≥50% probability of meeting the global target for men, and 29 countries for women (Figure 4).

*Number of people with diabetes*

The number of adults with diabetes in the world increased from 108 million in 1980 to 422 million in 2014 (Figure 5). East Asia and South Asia experienced the largest rises, and had the largest number of people with diabetes in 2014, 106 and 86 million respectively. 40% of the rise in the number of people with diabetes has been due to population growth and ageing, 28% to the rise in age-specific prevalences, and the remaining 32% to the interaction of the two, i.e. an older and larger population with higher age-specific prevalences.

One half of the adults with diabetes lived in five countries in 2014: China, India, USA, Indonesia and Brazil (Figure 6). These countries also accounted for 50% of the world’s adult population in 2014. Although the top three countries on this list remained unchanged from 1980 to 2014, the global shares of people with diabetes who live in China and India increased, in contrast to USA, whose share decreased. The rise in China’s and India’s shares may be due to the fact that their shares of adult populations increased. The share of the adult population of the USA also increased, in contrast to its share of diabetes. Other low- and middle-income countries like Pakistan, Mexico and Egypt have replaced European ones like Germany, Ukraine, Italy and UK on the list of top ten countries with the most people with diabetes.

**Discussion**

We used worldwide population-based data to document the global diabetes epidemic since 1980. Over this period, age-standardised diabetes prevalence in adults increased or at best remained unchanged in every country. It more than doubled in men and increased by 60% in women globally, hence shifting from an excess prevalence in women in 1980 to higher prevalence among men in 2014.[18](#_ENREF_18),[19](#_ENREF_19) This rise in prevalence has been compounded by population growth and ageing, hence quadrupling the number of people with diabetes over these 35 years. The burden of diabetes, in terms of both prevalence and number of people with diabetes, has increased more in low- and middle-income countries than in high-income countries. The highest national prevalences, generally those in Oceania, and the Middle East and North Africa, are now 5-10 times the lowest ones, which are in some Western European countries.

Our estimates of diabetes prevalence for 2013 for the world as a whole are similar to those by the IDF,[5](#_ENREF_5),[6](#_ENREF_6) but there were differences between our and IDF’s estimates in some countries and regions. In particular, we estimated a higher age-standardised prevalence of diabetes in Middle East and North Africa than the IDF. The IDF does not estimate trends, hence it was not possible to compare our trend estimates. Our finding that diabetes prevalence was low in much of Asia and sub-Saharan Africa in the 1980s and 1990s is consistent with other studies that had found low prevalences in these regions in those decades.[20](#_ENREF_20),[21](#_ENREF_21) Our finding that diabetes prevalence did not increase in continental Western Europe (especially in Northern Europe) is also consistent with reports from Sweden,[22](#_ENREF_22) Germany[23](#_ENREF_23) and Switzerland[24](#_ENREF_24) that covered a subset of our analysis years. Similarly, our estimated increases for high-income English-speaking countries are consistent with studies that had analysed repeated population-based surveys in the USA[25](#_ENREF_25) and the UK.[26](#_ENREF_26),[27](#_ENREF_27) A meta-analysis of 15 studies in Japan reported no increase in diabetes prevalence,[28](#_ENREF_28) as observed here. Several recent reports have also documented similar increases in diabetes prevalence to those observed in our analysis in China,[29](#_ENREF_29),[30](#_ENREF_30) India,[31-34](#_ENREF_31) Iran,[35](#_ENREF_35) Turkey[36](#_ENREF_36) and Saudi Arabia.[37](#_ENREF_37) Finally, our finding on the slower rise in diabetes prevalence among women compared to men is consistent with historical data in a few high-income countries.[18](#_ENREF_18),[19](#_ENREF_19)

The larger rise in diabetes prevalence in low- and middle-income countries than in high-income countries, and the mostly flat trends in Europe (especially in North Western Europe) may be due to a number of factors. First, adiposity, which is an important risk factor for diabetes, has increased substantially more, and is now higher, in many low- and middle-income countries than in continental Europe and high-income Asia Pacific countries, especially for women.[16](#_ENREF_16) Second, regional differences in diabetes may be partly due to differences in genetic susceptibility or phenotypic differences arising from inadequate foetal and childhood nutrition and growth; earlier onset of β-cell dysfunction may be one differentiating characteristic of Asian compared with European populations.[38-42](#_ENREF_38) Third, better-resourced health systems in Europe and other high-income countries may identify people with diabetes or at high risk of diabetes at an earlier stage, and use lifestyle and dietary modification and/or medications to prevent or delay its onset.[43-45](#_ENREF_43) Currently, information on what proportion of people with diabetes are diagnosed and receive treatment is limited to one or a small number of countries. Consistent information on diagnosis and treatment coverage will be increasingly important as universal health coverage becomes a central theme of global health efforts, and should be a focus of future analyses. Finally, in addition to total caloric intake and adiposity, dietary composition and physical activity may affect diabetes risk, and contribute to differences in regional trends.[46](#_ENREF_46) There is a need to investigate these and other potential reasons for the divergent trends in diabetes prevalence. Finally, the shift in diabetes burden from women towards men may be due to men having higher prevalences of some diabetes risk factors such as smoking, or being at a risk of diabetes at lower BMI levels compared with women.[18](#_ENREF_18),[19](#_ENREF_19)

The strengths of our study include its scope of making consistent and comparable estimates of trends in diabetes prevalence, and of the probabilities of meeting the global diabetes target. We used an unprecedented amount of population-based data from countries where 90% of the global adult population lives. We used only data from studies that had measured a diabetes biomarker to avoid bias in self-reported-only data. Data were analysed according to a common protocol, and the characteristics and quality of data sources were rigorously verified through repeated checks by Collaborating Group members from each country. We pooled data using a statistical model that took into account the epidemiological features of diabetes, including nonlinear time trends and age associations, and used all available data while giving more weight to national data than to sub-national and community sources.

Despite our extensive efforts to identify and access worldwide population-based data, some countries had no or few data sources, especially those in sub-Saharan Africa, the Caribbean, Central Asia and Eastern Europe. Estimates for these countries relied mostly or entirely on the statistical model, which shares information across countries and regions through its hierarchy and through predictive covariates. The absence or scarcity of data is reflected in wider uncertainty intervals of our estimates for these countries and regions, seen in Figure 1 and Appendix Figure 5. Diabetes was reported using a definition other than our primary outcome in some data sources, either because FPG was not measured or because individual-level data could not be accessed. To overcome this issue, we systematically used the reported metrics to estimate our primary outcome; the cross-walking regressions used for this purpose had high predictive accuracy. The share of studies that used a portable device (instead of laboratory analysis) for measuring diabetes biomarkers has increased over time. We do not expect the rise in the use of portable devices to affect the estimated levels and trends because their higher use in population-based research is partly due to increasing similarity between their measurements and those in laboratory-based tests,[47](#_ENREF_47),[48](#_ENREF_48) facilitated by more advanced technologies and better standardization. Further, although our primary outcome is consistent with the Global Monitoring Framework for NCDs, diabetes prevalence based on FPG alone is lower than that based on the combination of FPG and 2hOGTT.[8](#_ENREF_8) Using a conversion regression similar to those in the Appendix, age-standardised global adult diabetes prevalence would be 10.0% (8.0-12.5) for men and 8.8% (7.2-10.7) for women, if diabetes had been defined as FPG ≥7.0 mmol/L or 2hOGTT ≥11.1 mmol/L or history of diagnosis with diabetes or using insulin or oral hypoglycaemic drugs. Finally, the survey data did not allow separating Type 1 and Type 2 diabetes because distinguishing Type 1 and Type 2 diabetes is difficult in adults;[49-51](#_ENREF_49) most (85-95%) of diabetes cases in adults are Type 2.[50](#_ENREF_50),[52](#_ENREF_52) Therefore, the observed rise in diabetes prevalence among adults is quite likely to be due to increases in Type 2 diabetes.

Diabetes and its macrovascular and microvascular complications account for over 2 million annual deaths,[1](#_ENREF_1) and are the 7th leading cause of disability in the world.[53](#_ENREF_53) Diabetes is also a risk factor for tuberculosis, another condition with large burden in low- and middle-income countries.[54](#_ENREF_54) Diabetes and its complications also impose substantial economic costs on patients, their families, health systems and national economies due to direct costs of treatment and loss of work and wages.[2](#_ENREF_2) Based on the estimates of the number of people with diabetes in 2014 in this study, and cost estimates from a systematic review,[2](#_ENREF_2) the direct annual cost of diabetes in the world is over 827 billion dollars, with China (170 billion), USA (105 billion), India (73 billion) and Japan (37 billion) experiencing the largest costs. Nearly 60% of the global costs is borne by low- and middle-income countries, where substantial parts of treatment costs are paid out of pocket,[2](#_ENREF_2) and hence affects treatment utilisation and adherence and leads to financial hardship for patients and their families.

Glucose lowering using lifestyle modification and medications among people with diabetes, especially if started early, can delay progression to microvascular complications.[55-57](#_ENREF_55) Although evidence from trials on benefits of intensive glucose lowering for macrovascular benefits is mixed,[55](#_ENREF_55),[58-60](#_ENREF_58) long-term glycaemic control and lowering blood pressure and serum cholesterol also reduce the risk of adverse cardiovascular outcomes.[61](#_ENREF_61),[62](#_ENREF_62) However, the effectiveness of these interventions at the population level has been modest, both because many diabetes cases remain undiagnosed,[9-11](#_ENREF_9) and because adherence to treatment is typically lower in general populations than those enrolled in clinical trials.[63-65](#_ENREF_63)

Therefore, reducing the global health and economic burden of diabetes should emphasise preventing or delaying its onset, through enhancing healthy behaviours and diets at the population level and through early detection and management of high-risk individuals. There has been little success in preventing obesity,[16](#_ENREF_16) the most important risk factor for diabetes, at the population level although the global target on obesity may engender new efforts and policy innovations. As these policies are implemented, identifying people at high risk of diabetes, especially those with impaired glucose tolerance, through the primary care system and using advice and support to induce and maintain lifestyle change, possibly together with medications such as metformin, may be the only short-term approach for global diabetes prevention.[44](#_ENREF_44),[64](#_ENREF_64),[66](#_ENREF_66),[67](#_ENREF_67) Such programmes have been implemented in a few high- and middle-income countries,[45](#_ENREF_45),[68](#_ENREF_68),[69](#_ENREF_69) but their success requires a financially accessible primary care system that makes diabetes prevention and management a priority, and is staffed and resourced to support lifestyle change and improve access and adherence to medication.[10](#_ENREF_10),[43](#_ENREF_43),[45](#_ENREF_45),[64](#_ENREF_64),[68](#_ENREF_68),[70](#_ENREF_70)

**Research in Context**

*Evidence before this study*

We searched Medline (via PubMed) for articles published between 1st January 1950 and 11th December 2013 using the search terms (“Blood Glucose”[MAJR] OR “Diabetes Mellitus”[MAJR:NoExp] OR “Diabetes Mellitus, Type 2”[MAJR:NoExp] OR “Diabetes Mellitus, Type 1”[MAJR:NoExp] OR “Prediabetic state”[MAJR] OR “Hyperglycemia”[MAJR] OR “Hemoglobin A, Glycosylated”[MAJR]) AND (“Humans”[Mesh]). Articles were screened according to the inclusion and exclusion criteria described in the Appendix.

A few studies report on diabetes trends in one or small number of countries.[22-37](#_ENREF_22) A previous study on trends in mean FPG reported diabetes trends to 2008 as secondary outcome which was estimated from mean FPG.[4](#_ENREF_4) This study was done before the global target on diabetes was agreed upon, and hence there are no recent data. International Diabetes Federation periodically reports diabetes prevalence,[5](#_ENREF_5),[6](#_ENREF_6) but does not analyse trends, uses some sources that are solely based on self-reported diabetes, and does not fully account for differences in diabetes definitions in different data sources.[7](#_ENREF_7)

*Added value of this study*

This study provides the longest and most complete estimates of trends in diabetes prevalence for all the countries in the world. We were able to achieve this level of detail by re-analysing and pooling hundreds of population-based sources with actual measurements of at least one diabetes biomarker, and systematically converting all data sources to a common definition of diabetes. We also systematically projected recent trends into the future, and assessed the probability of achieving the global diabetes target.

*Implications of all the available evidence*

Since 1980, age-standardised diabetes prevalence in adults increased or at best remained unchanged in every country. The burden of diabetes, in terms of both prevalence and number of people, has increased faster in low- and middle-income countries than in high-income countries. If post-2000 trends continue, the probability of meeting the global diabetes target will be <1% for men and 1% for women in the world as a whole.

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**Contributions**

ME and GD designed the study and oversaw research. Members of the Country and Regional Data Group collected and reanalysed data, and checked pooled data for accuracy of information about their study and other studies in their country. BZ, YL, KH and MDC led data collection. BZ, JB and YL led the statistical analysis and prepared results. Members of the Pooled Analysis and Writing Group collated data, checked all data sources in consultation with the Country and Regional Data Group, analysed pooled data, and prepared results. ME wrote the first draft of the report with input from other members of Pooled Analysis and Writing Group. Members of Country and Regional Data Group commented on draft report.

**Figure 1:** Trends in age-standardised (solid line) and crude (dashed line) prevalences of diabetes by sex and region in people aged 18 years and older. The lines show the posterior mean estimates and the shaded area shows the 95% credible interval for age-standardised prevalence. See Appendix Figure 5 for trends by country, and Appendix Table 6 for numerical results by country.

**Figure 2:** Age-standardised prevalence of diabetes by sex and country in 1980 and 2014 in people aged 18 years and older.

**Figure 3:** Comparison of age-standardised prevalence of diabetes in people aged 18 years and older in 1980 and 2014.

**Figure 4:** Probability of achieving the target of halting the rise of diabetes in people aged 18 years or older compared to its 2010 levels by country if post-2000 trends continue.

**Figure 5:** Trends in the number of adults aged 18 years and older with diabetes (A) by region and (B) decomposed into the contributions of population growth and ageing, rise in prevalence, and interaction of the two. The contribution of population growth and ageing is the change in number of people with diabetes if age-specific prevalences had been the same as 1980 but population size and age structure had changed as it has. The contribution of rise in prevalence is the change in number of people with diabetes if population size and age structure had been the same as 1980 but age-specific prevalences had changed as they have. The interaction represents having a larger and older population at higher prevalences in each age group. See Appendix Figure 4 for regional results.

**Figure 6:** Ten countries with the largest number of adults with diabetes in 1980 and 2014. Colours for each country indicate its region, using the same colour scheme as in Figure 3.

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