



# Technical Document for the APHO Diabetes Prevalence Model for England

## Introduction

The APHO Diabetes Prevalence Model provides estimates of total (diagnosed and undiagnosed) diabetes prevalence for England. It builds on the underlying principles and structure of the PBS Diabetes Prevalence Model<sup>1</sup> originally developed in 2004. The APHO Diabetes Prevalence Model uses data from the Health Surveys for England to provide up to date and robust estimates of diabetes prevalence. The model also provides uncertainty limits for the estimates to illustrate the extent of likely uncertainty around the point estimates.

The APHO Diabetes Prevalence Model has been developed in conjunction with a working group of academics, clinicians and practitioners in the diabetes community (see end of document for membership of the group).

## The Model

The APHO Diabetes Prevalence Model for England provides estimates of the prevalence of diabetes in people aged 16 years and older for England, Strategic Health Authorities and Primary Care Trusts. Point estimates and uncertainty limits are provided for 2009, 2010, 2015, 2020, 2025 and 2030. The model estimates take into account the age, sex, and ethnic group distribution, as well as deprivation and projected trends in obesity. All data relating to diabetes prevalence have been taken from the Health Surveys for England (predominately those for 2006 and 2004). All population data are based on population estimates and projections by the Office for National Statistics.

## Underlying diabetes prevalence data

The underlying age and sex specific prevalence of self reported diagnosed diabetes were taken from the Health Survey for England 2006. In addition the 2004 Health Survey for England was used as explained below.

## Taking account of differences in prevalence by ethnic group

The Health Survey for England 2004 included a booster sample to provide robust data for minority ethnic groups in England. Age adjusted relative risks of having diagnosed diabetes for minority ethnic groups compared to the general population have been published for men and women<sup>2</sup>. Sex specific relative risks compared to the general population of reporting diabetes diagnoses for people from Black African and Black Caribbean ethnic groups were combined weighted by the proportion of the

<sup>1</sup> <http://www.yhpho.org.uk/resource/view.aspx?RID=9906>

<sup>2</sup> [http://www.ic.nhs.uk/webfiles/publications/healthsurvey2004ethnicfull/HealthSurveyforEnglandVol1\\_210406\\_PDF.pdf](http://www.ic.nhs.uk/webfiles/publications/healthsurvey2004ethnicfull/HealthSurveyforEnglandVol1_210406_PDF.pdf)

English population from these ethnic groups in 2007. Similar calculations were undertaken to provide sex specific relative risks of reporting diagnosed diabetes for South Asian (Indian, Pakistani and Bangladeshi) men and women compared to the general population.

These relative risks by ethnicity have been applied to the age and sex specific prevalence rates of diagnosed diabetes for the general population reported in the 2006 Health Survey for England. This provides age, sex and ethnic group specific prevalence estimates for diagnosed diabetes.

The following assumptions have been made in applying an adjustment for ethnic group

1. That the age adjusted relative risks of self-reported diabetes by ethnic group reported in the Health Survey for England 2004 have not altered and there are no regional variations across England in the relative risk of diabetes among Black African, Black Caribbean, Indian, Pakistani and Bangladeshi ethnic groups.
2. That people from White, Mixed, other Black, other Asian and other ethnic groups have a similar risk of diabetes as the general population.

### **Accounting for undiagnosed diabetes**

The model uses a definition of total diabetes prevalence as self reported doctor diagnosed diabetes or a glycated haemoglobin (HbA1c) of 6.5% or greater<sup>3</sup>. Using this definition 26.4% of all men and 21.7% of all women with (total) diabetes have undiagnosed diabetes.

Analysis of the Health Survey for England found no clear evidence of variation in the percentage of people with diabetes that are undiagnosed by age, ethnic group or deprivation. This is consistent with another recent study<sup>4</sup>. The age, sex and ethnic group specific prevalence rates of diagnosed diabetes were adjusted upwards using the proportion of undiagnosed diabetes by sex to provide estimates of the total prevalence of diabetes.

### **Accounting for deprivation**

The 2006 Health Survey for England measures deprivation using the Index of Multiple Deprivation 2004 and reports data based on quintiles. Analysis shows that there is a modest deprivation gradient in the prevalence of diabetes with higher prevalence of diabetes in more deprived populations compared to more affluent populations.

The distribution of the population within each quintile of the Indices of Multiple Deprivation 2007 was calculated for each area (SHAs and PCTs). These data were combined with the relative risks of having diabetes in each quintile nationally to create a deprivation adjustment index. The age, sex and ethnic group adjusted estimated total diabetes prevalence was then multiplied by the deprivation adjustment index to account for the pattern of deprivation within each area. The

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<sup>3</sup> International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care* 32:1327-1334, 2009

<sup>4</sup> Pierce MB, Zaninotto P, Steel N, Mindell J. Undiagnosed diabetes-data from the English longitudinal study of ageing *Diabet Med.* 2009; **26**: 679-85.

deprivation adjustment does not alter the total number of people estimated to have diabetes in England but alters their distribution across SHAs and PCTs.

### **Uncertainty limits**

The diabetes prevalence estimates produced by the APHO Diabetes Prevalence Model are subject to uncertainty, as any point estimates are. Uncertainty limits have been calculated to give an indication of the likely range of this uncertainty. These have been based on the principles of multi-variate sensitivity analysis and have been calculated using

- 95% confidence intervals for the age and sex specific prevalence rates
- 95% confidence intervals for the relative risk of diabetes among people from Black and South Asian ethnic groups
- 95% confidence intervals for the relative risk of having diabetes for overweight and obese men and women compared to men and women of healthy weight
- 95% confidence intervals for the proportion of people with diabetes that are undiagnosed

The values that would result in the lowest prevalence estimate were used to create the lower uncertainty limit and those values that would result in the highest prevalence estimate were combined to give an upper uncertainty limit. This produced an uncertainty range that took into account the uncertainty around the underlying prevalence estimates used in the model. By definition there is greater uncertainty around point estimates for smaller populations. 95% confidence intervals around the lower and upper uncertainty limits using the relevant population data were calculated. The final uncertainty range was taken as the lower confidence interval of the original lower uncertainty limit and the upper confidence interval for the original upper uncertainty limit. This provides an uncertainty range that includes an adjustment for the population size

### **Forecasting prevalence over time, accounting for trends in body mass index**

It is known that the risk of having type 2 diabetes which represents 85%-90% of diabetes in the UK is higher among people who are overweight and obese. The sex specific relative risks of having self-reported diabetes for people who were overweight and who were obese were calculated using data from the Health Survey for England 2006. Overweight was defined as a Body Mass Index of 25 kg/m<sup>2</sup> or greater but less than 30 kg/m<sup>2</sup>. Obese was defined as a Body Mass Index of 30 kg/m<sup>2</sup> or greater. Forecasts of the prevalence of overweight and obese up until 2030 were based on linear extrapolations of the trends shown between 2003 and 2008 in the annual Health Surveys for England. The relative risks of having diabetes if overweight or obese were combined with the forecasted prevalence rates for overweight and obesity to create an obesity adjustment index. This index was used to adjust the age, sex and ethnic group prevalence rates (including the adjustment for undiagnosed diabetes) to reflect estimated increases in diabetes prevalence since 2006. It is assumed that the trends in the prevalence of overweight and obesity found in the Health Survey of England from 2003 to 2008 will continue to 2030 and that these trends apply uniformly across England.

## **Population data**

The population data used in the APHO Diabetes Prevalence Model are based on the Office for National Statistics populations by ethnic group for 2002 to 2007<sup>5</sup>. Trends in the proportion of the population in sex specific ten year age groups between 2002 and 2007 have been extrapolated to 2030 using linear regression. These proportions have then been applied to the 2006 based population projections produced by the Office for National Statistics<sup>6</sup>. The population calculations assume that the changes in the population by ethnic group found between 2002 and 2007 will continue to apply from 2008 to 2030.

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### Working Group (alphabetical order)

Dr Amanda Adler, Institute of Metabolic Science, Addenbrooke's Hospital, Cambridge.

Dr Liz Allan, NHS Diabetes.

Dr Nita Forouhi, MRC Epidemiology Unit, Institute of Metabolic Science, Addenbrooke's Hospital, Cambridge.

Professor Liddy Goyder, Public Health Section, ScHARR, University of Sheffield.

Naomi Holman (Chair), Diabetes Health Intelligence, Yorkshire and Humber Public Health Observatory, York.

Howard Seymour, Innove, Manchester.

Dr Sarah Wild, University of Edinburgh, Edinburgh

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<sup>5</sup> <http://www.statistics.gov.uk/statbase/product.asp?vlnk=14238>

<sup>6</sup> <http://www.statistics.gov.uk/statbase/product.asp?vlnk=997>