



Public Health  
England

# Adult obesity and type 2 diabetes

# About Public Health England

Public Health England's mission is to protect and improve the nation's health and to address inequalities through working with national and local government, the NHS, industry and the voluntary and community sector. PHE is an operationally autonomous executive agency of the Department of Health.

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# Summary

## Prevalence

Being overweight or obese is the main modifiable risk factor for type 2 diabetes. In England, obese adults are five times more likely to be diagnosed with diabetes than adults of a healthy weight. Currently 90% of adults with type 2 diabetes are overweight or obese. People with severe obesity are at greater risk of type 2 diabetes than obese people with a lower BMI.

## Inequalities

Deprivation is closely linked to the risk of both obesity and type 2 diabetes. Prevalence of type 2 diabetes is 40% more common among people in the most deprived quintile compared with those in the least deprived quintile. People from black, Asian and other minority ethnic groups are at an equivalent risk of type 2 diabetes at lower BMI levels than white European populations.

## Health impact

People with diabetes are at a greater risk of a range of chronic health conditions including cardiovascular disease, blindness, amputation, kidney disease and depression than people without diabetes. Diabetes leads to a two-fold excess risk for cardiovascular disease, and diabetic retinopathy is the leading cause of preventable sight loss among people of working age in England and Wales. Diabetes is a major cause of premature mortality with around 23,300 additional deaths in 2010-11 in England attributed to the disease.

## Economic impact

It is estimated that in 2010-11 the cost of direct patient care (such as treatment, intervention and complications) for those living with type 2 diabetes in the UK was £8.8 billion and the indirect costs (such productivity loss due to increased death and illness and the need for informal care) were approximately £13 billion. Prescribing for diabetes accounted for 9.3% of the total cost of prescribing in England in 2012-13.

## Future trends

In England, the rising prevalence of obesity in adults has led, and will continue to lead, to a rise in the prevalence of type 2 diabetes. This is likely to result in increased associated health complications and premature mortality, with people from deprived areas and some minority ethnic groups at particularly high risk. Modelled projections indicate that NHS and wider costs to society associated with overweight, obesity and type 2 diabetes will rise dramatically in the next few decades.

# 1. Aim

The aim of this paper is to describe the relationship between obesity and diabetes to support public health policy makers and practitioners. The paper provides an overview of obesity and type 2 diabetes among adults, describing the epidemiology of each disorder, how the two conditions are linked and why they present a major public health challenge. Latest available data and evidence illustrate prevalence trends in both obesity and diabetes at a national and local level as well as the potential implications in terms of health consequences, inequalities and cost. The paper also signposts latest relevant policy and guidance documents.

# 2. Obesity and diabetes

Diabetes is a metabolic condition in which the body does not produce sufficient insulin to regulate blood glucose levels or where the insulin produced is unable to work effectively. There are two main types of diabetes:

*Type 1 diabetes* is an auto-immune condition in which the cells that produce insulin<sup>a</sup> are destroyed so lifelong treatment with insulin is required to prevent death. About 10% of people with diagnosed diabetes have type 1 diabetes.

*Type 2 diabetes* accounts for at least 90% of all cases of diabetes.<sup>1,2</sup> It occurs when the body either stops producing enough insulin for its needs or becomes resistant to the effect of insulin produced. The condition is progressive requiring lifestyle management (diet and exercise) at all stages. Over time most people with type 2 diabetes will require oral drugs and or insulin. Type 2 diabetes may remain undetected for many years.<sup>2</sup>

Obesity is only associated with type 2 diabetes and this paper does not cover type 1 diabetes, which has no association with obesity or other lifestyle factors, or other forms of diabetes such as gestational diabetes or MODY.<sup>b</sup> Some data and evidence sources in this paper do not specifically define diabetes type and where this occurs it is clearly described.

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<sup>a</sup> Insulin plays a key role in the regulation of carbohydrate, fat, and protein metabolism. Insulin preparations can be divided into 3 types: those with short duration which have a relatively rapid onset of action; those with intermediate action and those whose action is slower in onset and lasts for long periods

<sup>b</sup> Maturity Onset Diabetes of the Young

## The relationship between obesity and type 2 diabetes

There is a close association between obesity and type 2 diabetes. The likelihood and severity of type 2 diabetes are closely linked with body mass index (BMI). There is a seven times greater risk of diabetes in obese people compared to those of healthy weight, with a threefold increase in risk for overweight people.<sup>3</sup> Whilst it is known that body fat distribution is an important determinant of increased risk of diabetes, the precise mechanism of association remains unclear. It is also uncertain why not all people who are obese develop type 2 diabetes and why not all people with type 2 diabetes are obese.<sup>4,5</sup>

## 3. How common are obesity and diabetes?

62% of adults were overweight or obese in England in 2012

6% of people aged 17 years or older had diagnosed diabetes in England in 2013

Prevalence of both obesity and diabetes is rising in England

90% of adults with type 2 diabetes aged 16-54 years are overweight or obese

In England, 12.4% of people aged 18 years and over with obesity have diagnosed diabetes, five times that of people with a healthy weight

Men with a raised waist circumference are five times more likely to have diagnosed diabetes than those without a raised waist circumference; women are over three times more likely

### National prevalence estimates

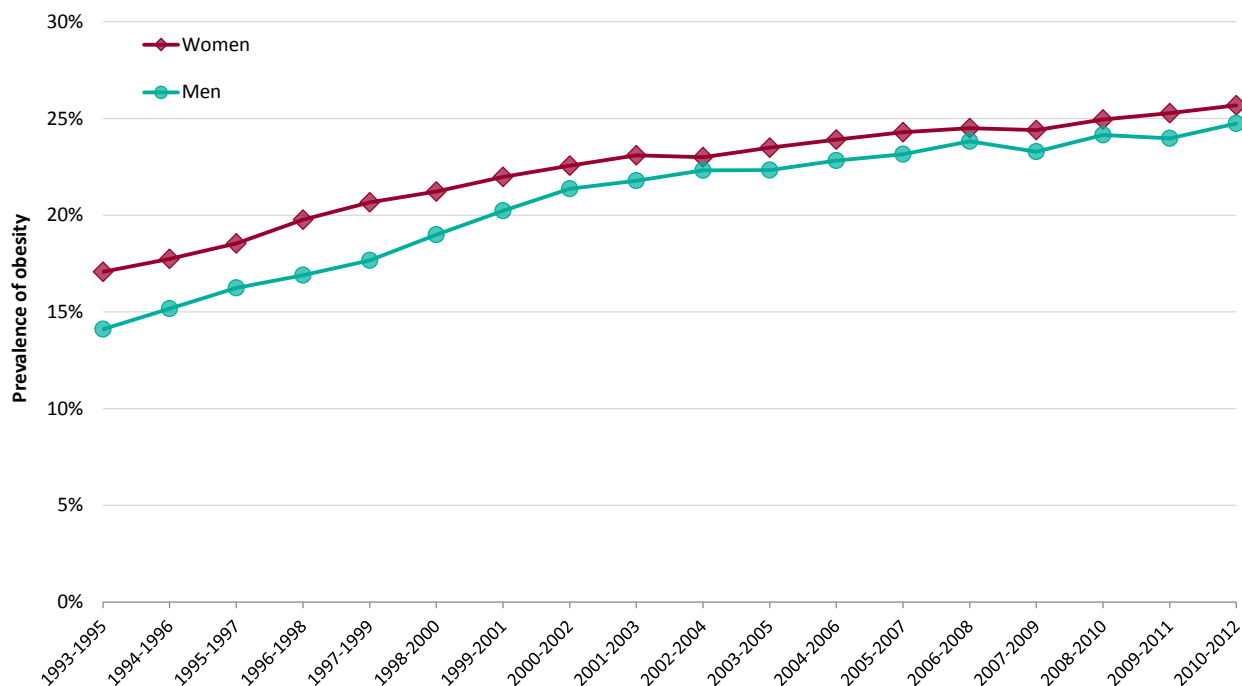
#### Obesity

In 2012, an estimated 62% of adults (aged 16 years and over) were overweight or obese in England (BMI  $\geq 25$ ), 24.7% were obese (BMI  $\geq 30$ ) and 2.4% were severely obese (BMI  $\geq 40$ ).<sup>6</sup>

The prevalence of obesity among adults increased sharply during the 1990s and early 2000s. The proportion who were categorised as obese increased from 13% of men in 1993 to 24% in 2012 and from 16% of women in 1993 to 25% in 2012. Obesity prevalence remains higher for women, but the gap between men and

women appears to have narrowed over time.<sup>7</sup> Some forecasts predict that by 2050, obesity will affect 60% of adult men and 50% of adult women.<sup>8</sup>

**Figure 1:** Prevalence of obesity among adults Health Survey for England 1993-2012 (3-year rolling average)



Adult (aged 16+ years) obesity: BMI  $\geq 30\text{kg/m}^2$

Source: Health Survey for England, 1993-2012.

Joint Health Surveys Unit (Nat Cen Social Research & UCL) 2014. The Health and Social Care Information Centre: Leeds.

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## Diabetes

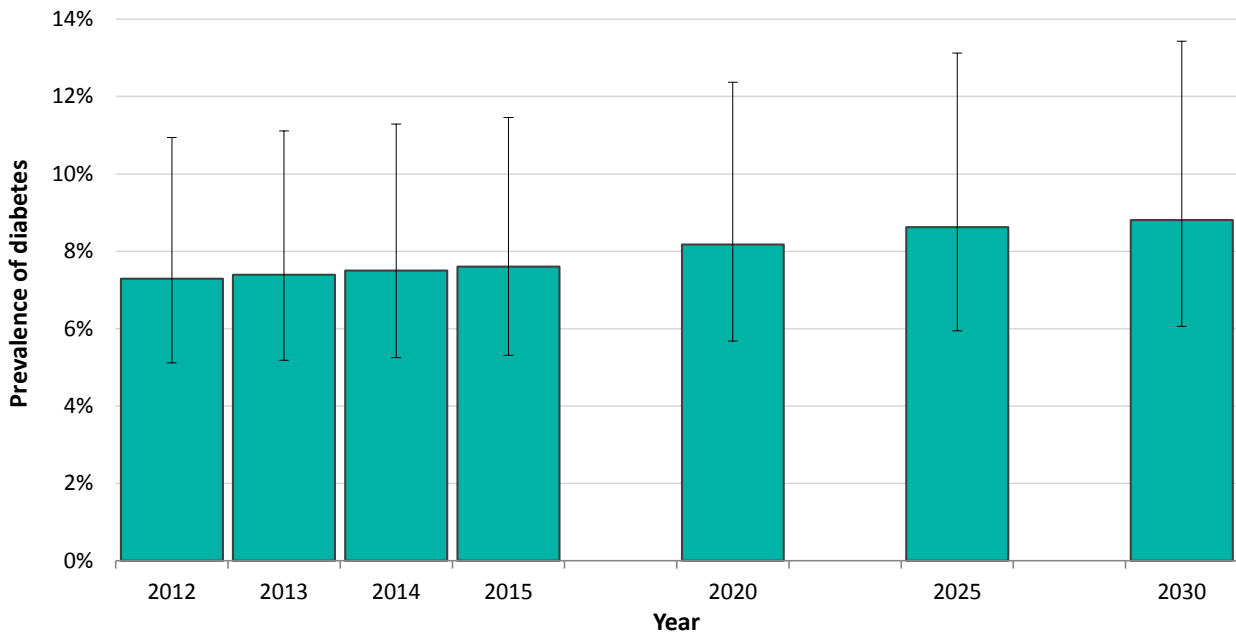
Diabetes prevalence in England is rising. In 2013, 2.7 million or 6% of the adult population had diagnosed diabetes in England, an increase of 137,000 people since 2012.<sup>9</sup> Additionally, approximately a quarter of people with type 2 diabetes have the condition but are unaware of it,<sup>10</sup> as a result diagnosed cases understate the true prevalence. When these undiagnosed people are taken into account it has been estimated that the true prevalence in England is around 3.2 million or 7.4% of the adult population.<sup>11</sup>

Because of the impact of obesity on type 2 diabetes, the rising prevalence of obesity has led, and will continue to lead, to a rise in the prevalence of diabetes. Figure 2 illustrates this and shows that the total number of adults with diabetes is



projected to rise to 4.6 million or 9.5% of the adult population by 2030.<sup>c</sup> Approximately a third of this increase is attributable to obesity, whilst the rest is due to aging and the changing ethnic structure of the population.<sup>10</sup>

**Figure 2: Adult diabetes prevalence in England 2012-2030**



Source: Yorkshire and Humber Public Health Observatory (YHPHO) Prevalence Model<sup>d</sup> for local authorities and clinical commissioning groups published November 2012 by YHPHO. Access the [tool](#).  
Note: Includes people age 16 years or older who have all types of diabetes (diagnosed and undiagnosed) adjusted for age, sex, ethnic group and deprivation.

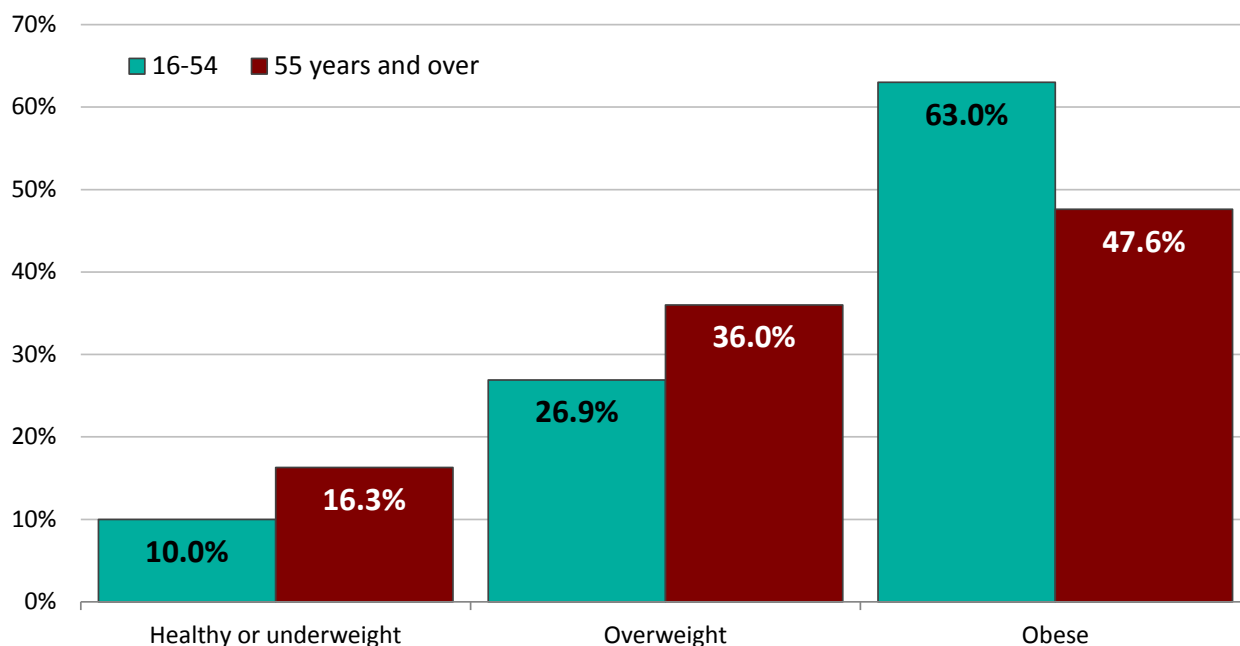
### Obesity prevalence among adults with type 2 diabetes

National Diabetes Audit (NDA) data show that in England, 90% of adults with type 2 diabetes aged 16-54 years were overweight or obese, compared to only 10% who were a healthy weight or underweight in 2009-10.

<sup>c</sup> This is almost all attributable to the rise in type 2 diabetes, not type 1 diabetes which has no association with obesity.

<sup>d</sup> The Diabetes Prevalence Model is based on Health Survey for England (HSE) data and includes large uncertainty limits because of small numbers. A new diabetes prevalence model is currently being worked on using National Diabetes Audit (NDA) data to be available late 2014.

**Figure 3:** Weight status among adults with type 2 diabetes, 2009-10



Source: National Diabetes Audit 2009-10

### Diabetes prevalence among adults who are obese

Analysis of combined Health Survey for England (HSE) data from 2010-12 show that 12.4% of people aged 18 years and over with obesity have diagnosed diabetes, five times that of people of a healthy weight. (Table 1)

**Table 1:** Doctor diagnosed diabetes<sup>1</sup> prevalence by weight status and gender for adults aged 18 years and over 2010-12, England

	Underweight	Healthy weight	Overweight	Obese (incl severely obese)
Female	1.9%	1.9%	4.3%	10.7%
Male	0.0%	3.3%	6.0%	14.6%
<b>Total</b>	<b>1.3%</b>	<b>2.4%</b>	<b>5.2%</b>	<b>12.4%</b>

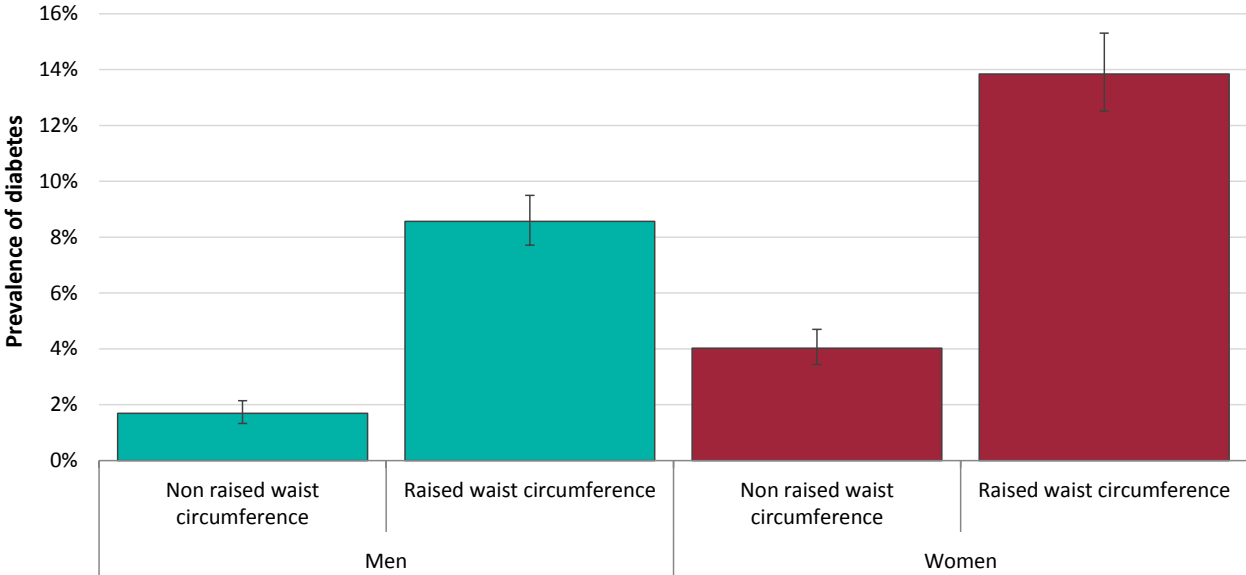
Source: Health Survey for England combined data 2010-12. Joint Health Surveys Unit (Nat Cen Social Research & UCL) 2014. The Health and Social Care Information Centre: Leeds. Copyright © 2014, Re-used with the permission of The Health and Social Care Information Centre. All rights reserved.

Excludes women who only had diabetes during pregnancy. No distinction is made between type 1 and type 2 diabetes

Men with a raised waist circumference (greater than 102cm) are five times as likely to have doctor diagnosed diabetes, compared to those without a raised waist

circumference, and women with a raised waist circumference (greater than 88cm) are over three times as likely.<sup>e</sup> (Figure 4)

**Figure 4:** Doctor diagnosed diabetes prevalence by waist circumference (greater than 88cm for women and greater than 102cm for men) and gender for adults aged 18 years and over, 2009-11, England



Source: Health Survey for England combined data 2009-11. Joint Health Surveys Unit (Nat Cen Social Research & UCL) 2014. The Health and Social Care Information Centre: Leeds. Copyright © 2014, Re-used with the permission of The Health and Social Care Information Centre. All rights reserved.

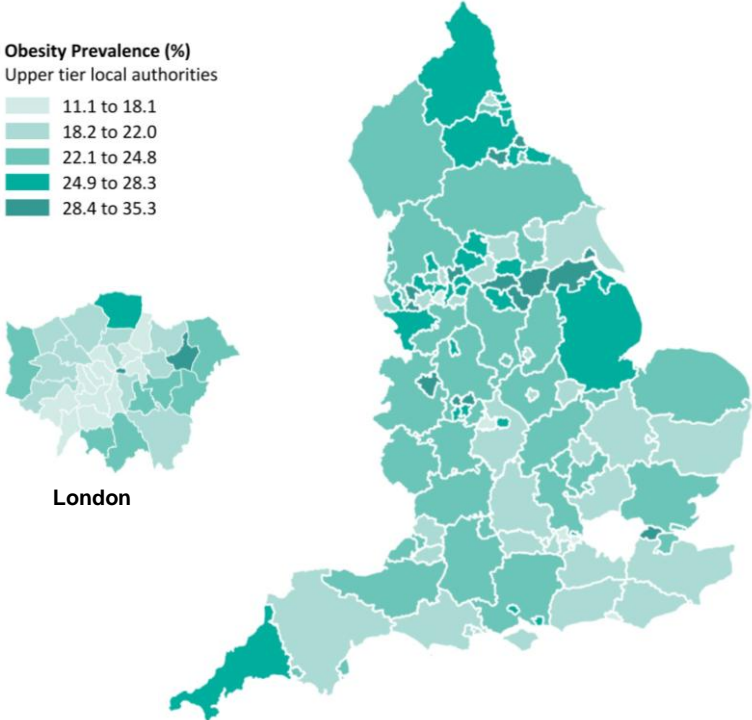
### Geographical variation

The following maps provide an overview of obesity and diabetes prevalence among adults by local authority in England.<sup>f</sup> Patterns across the country show some similarities for the two conditions.

<sup>e</sup> See page 13 for more information on the link between waist circumference and diabetes.

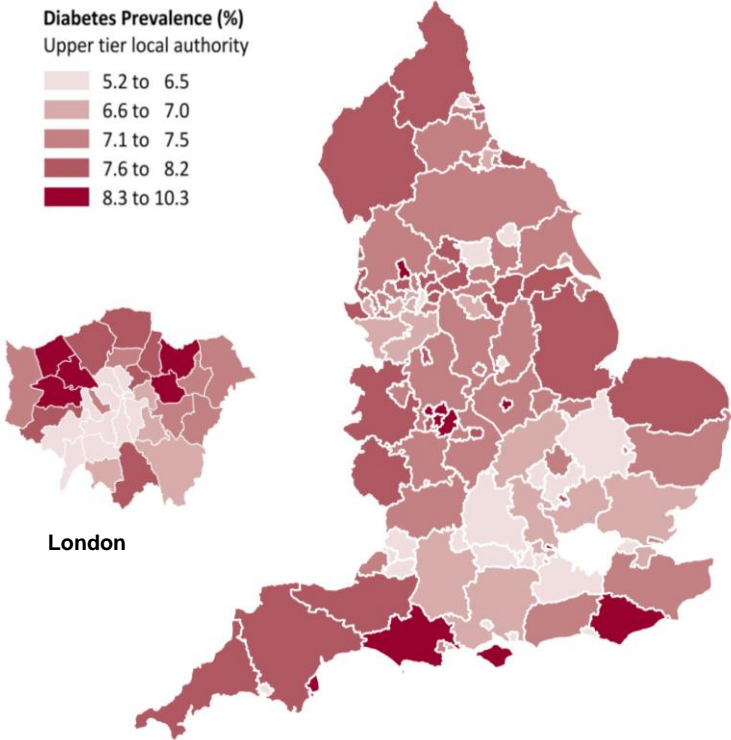
<sup>f</sup> Local Authority level data may mask *variation* at lower geographical *areas*.

**Figure 5:** Adult obesity prevalence by upper tier local authority, England, 2012



Source: Sport England, Active People Survey <http://www.noo.org.uk/visualisation>  
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**Figure 6:** Modelled diagnosed and undiagnosed diabetes prevalence by upper tier local authority, England, 2012



Source: YHPHO Diabetes Prevalence Model. Diabetes Prevalence Model for local authorities in England 2012  
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Public Health England will be publishing a diabetes **Longer Lives** atlas in summer 2014. It will include indicators on diabetes prevalence and risk factors including obesity and Index of Multiple Deprivation, as well as variation in care and outcomes of diabetes by GP practice, Clinical Commissioning Group and local authority.

## 4. How are obesity and diabetes linked?

Being overweight or obese is the main modifiable risk factor for type 2 diabetes

As BMI increases, so does the risk of type 2 diabetes

People with severe obesity are particularly at risk of type 2 diabetes

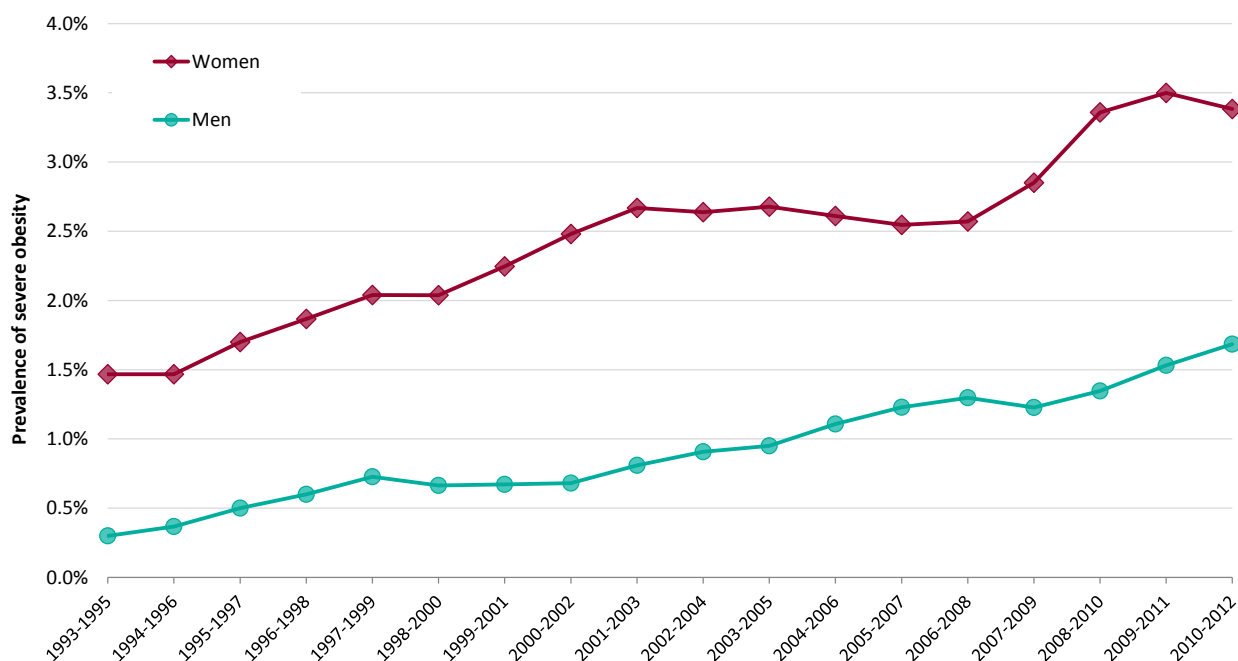
Having a large waist circumference increases the likelihood of developing type 2 diabetes

### BMI and waist circumference

Being overweight or obese (a BMI of  $25\text{kg/m}^2$  or more) is the main modifiable risk factor for type 2 diabetes.<sup>12</sup> The risk of developing type 2 diabetes is associated with incremental increases in body weight in early adulthood.<sup>13</sup> In addition, duration of obesity has also been found to increase risk of developing type 2 diabetes, with greater risk among people who have been obese for longer periods of time.<sup>14</sup>

A recent study found that severely obese people (BMI  $\geq 40$ ) were at an even greater risk of type 2 diabetes, when compared to obese people with a lower BMI (BMI 30-39.9).<sup>15</sup> This may have significant implications for health services given the increasing trend of severe obesity in adults in England as illustrated in Figure 7.

**Figure 7:** Trend in severe obesity among adults. Health Survey for England 1993-2012 (3-year rolling average)



Adult (aged 16+ years) severe obesity: BMI  $\geq 40\text{kg/m}^2$

Source: Health Survey for England 1993-12. Joint Health Surveys Unit (Nat Cen Social Research & UCL) 2014. The Health and Social Care Information Centre: Leeds. Copyright © 2014, Re-used with the permission of The Health and Social Care Information Centre. All rights reserved.

A large waist circumference is associated with increased likelihood of developing type 2 diabetes. Men are at higher risk of type 2 diabetes if they have a waist circumference of 94-102cm and are at very high risk if it is more than 102cm. Women are at higher risk if they have a waist circumference of 80-88cm and at very high risk if it is more than 88cm.<sup>12</sup>

## Linkage mechanisms

Theories of why obesity may lead to type 2 diabetes include:

- abdominal obesity may cause fat cells to release pro-inflammatory chemicals. These chemicals can make the body less sensitive to the insulin it produces by disrupting the function of insulin responsive cells and their ability to respond to insulin<sup>16,17</sup>
- obesity may trigger changes to the body's metabolism that cause adipose (fat) tissue to release increased amounts of fatty acids, glycerol, hormones, pro-inflammatory cytokines and other factors that are involved in the development of insulin resistance. When insulin resistance is accompanied by dysfunction of pancreatic islet beta-cells (the cells that release insulin) it leads to failure to control blood glucose levels<sup>18</sup>

## 5. Risk factors for type 2 diabetes

Obesity and overweight are major risk factors for type 2 diabetes

There is a clear association between increasing age and greater diabetes prevalence

Both obesity and type 2 diabetes are strongly associated with unhealthy diets and physical inactivity

People from black, Asian and other minority ethnic groups are at an equivalent risk of type 2 diabetes at lower BMI levels than white European populations

Deprivation is closely linked to the risk of type 2 diabetes

In addition to overweight and obesity, risk factors for developing type 2 diabetes include increasing age, lifestyle factors such as physical inactivity, unhealthy diet, a family history of type 2 diabetes and a history of gestational diabetes<sup>19</sup> or polycystic ovarian syndrome.<sup>20</sup> People from some black and minority ethnic groups and those from lower socioeconomic groups are particularly at risk.<sup>12</sup> The more risk factors present, the greater a person's chance of developing type 2 diabetes.<sup>21</sup>

### Age

There is a clear association between increasing age and greater diabetes prevalence. Less than 2% of people aged 16-34 years are estimated to have diabetes compared to 5.1% of people aged 35-54 years, 14.3% of people aged 55-74 years and 16.5% of those aged over 75 years.<sup>22</sup> The National Institute for Health and Care Excellence (NICE) state that being older than 40 years, or older than 25 years for some black and minority ethnic groups, is an important risk factor for developing type 2 diabetes.<sup>12</sup>

### Lifestyle factors

Both obesity and type 2 diabetes are strongly associated with an unhealthy diet and physical inactivity. Physical and social environments are important influences on diet and physical activity behavior along with interrelated economic, psychological and cultural factors.<sup>23</sup> Sedentary behavior is also linked to obesity and a recent British study found that people with type 2 diabetes recorded greater amounts of sedentary time compared with their non diabetic counterparts.<sup>24</sup>

A large US study found that adults aged 50-71 years with a low-risk lifestyle profile, including not smoking, engaging in regular physical activity, a healthy diet,

moderate alcohol consumption and having a healthy body weight, had a dramatically lower risk of diabetes than those who did not have a low-risk profile.<sup>25</sup> Results from a further US study of adults aged 65 years and older suggests that, even later in life, the great majority of cases of diabetes are related to lifestyle factors.<sup>26</sup> A recent meta-analysis found that the risk of developing type 2 diabetes is 30-40% higher for regular smokers than for non-smokers and that there is a positive dose-response relationship between the number of cigarettes smoked and the risk of developing diabetes.<sup>27</sup>

Exercise plus dietary changes have been found to be effective in preventing the onset of type 2 diabetes in high risk individuals (those with impaired glucose tolerance or those with metabolic syndrome).<sup>9,28</sup> The Scientific Advisory Committee on Nutrition (SACN) published their draft report on **Carbohydrates and Health** on 26 June 2014 as part of a 9-week consultation ending on 1 September 2014. The final SACN report will be published in early 2015. SACN reviewed the evidence on a range of carbohydrates in the diet and their relationship to health, including the risk of obesity and type 2 diabetes. As part of their draft advice, SACN recommend that:

- the population average intake of free sugars<sup>h</sup> should be reduced to around 5% of dietary energy to reduce risk of weight gain and consequently type 2 diabetes
- consumption of sugars sweetened beverages should be minimized; there is evidence linking sugary drinks to weight gain and increased intake of these beverages is associated with higher risk of type 2 diabetes
- under a broader definition of fibre, intake should increase to 30g per day<sup>i</sup> because there is evidence that greater fibre intake is associated with a reduced risk of a range of disease outcomes, including type 2 diabetes

## Ethnicity

Type 2 diabetes prevalence is strongly associated with ethnicity.<sup>29</sup> Analysis of HSE 2004 data found that all minority ethnic groups (with the exception of Irish) have a higher risk of doctor-diagnosed diabetes compared to the general population. Women of Pakistani ethnicity are over five times more likely, and those

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<sup>9</sup> Metabolic syndrome is a complex condition linked to obesity that is characterized by a cluster of closely related clinical features, including insulin resistance, dyslipidaemia and hypertension.

<sup>h</sup> Free sugars refers to sugars that are added to foods by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit concentrates.

<sup>i</sup> This recommendation is an increase of about 6g/day compared with the current advice. Currently adults are advised to consume 18g dietary fibre/day using the long-standing definition of fibre; this is roughly equivalent to 24g according to the new, broader definition.



of Bangladeshi or black Caribbean ethnicity over three times more likely, to be diagnosed with diabetes compared to women in the general population. Bangladeshi men are almost four times more likely, and Pakistani and Indian men almost three times more likely to have doctor-diagnosed diabetes compared to men in the general population.<sup>j</sup>

Type 2 diabetes affects people of South Asian, African-Caribbean, Chinese or black African descent up to a decade or more earlier than white Europeans.<sup>30</sup> Recently a large scale study of Londoners revealed that by age 80 years, 40-50% of British South Asian, African and African-Caribbean men and women had developed diabetes, at least twice the proportion of white Europeans of the same age.<sup>31</sup>

The difference in prevalence of type 2 diabetes across ethnic groups is due to a complex and unresolved interplay of genetic susceptibility and environmental factors.<sup>32</sup> Evidence suggests that compared to white European populations, people from black, Asian and other minority ethnic groups are at higher risk of type 2 diabetes, other health conditions or mortality at equivalent BMI levels. NICE recommends using lower thresholds as a trigger to intervene to prevent ill health among these groups (23kg/m<sup>2</sup> BMI to indicate increased risk and 27.5kg/m<sup>2</sup> BMI to indicate high risk.)<sup>k,33</sup> A recent UK study found that non-white adults aged 40-69 years were two to four times more likely to have diabetes compared to white adults. Diabetes prevalence in South Asian groups with a BMI of 22kg/m<sup>2</sup> was equivalent to diabetes prevalence in white groups with a BMI of 30kg/m<sup>2</sup>.<sup>34</sup>

The higher risk for South Asian people living in England is at least partly due to the fact that they may accumulate significantly more 'metabolically active' fat<sup>l</sup> in the abdomen and around the waist than white European populations. This is also the case for those with a BMI in the 'healthy' range from 18.5-24.9kg/m<sup>2</sup>.<sup>12</sup>

## Deprivation

In England, type 2 diabetes is 40% more common among people in the most deprived quintile compared with those in least deprived quintile.<sup>m,29</sup> People in social class V (unskilled manual) are three and a half times more likely to be ill as a result of diabetic complications than those in social class I (professional)<sup>35</sup> and short term mortality risk from type 2 diabetes is higher among those living in more deprived areas in England.<sup>36</sup>

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<sup>j</sup> If revised thresholds were used, these estimates would be greatly increased.

<sup>k</sup> See appendix for further details.

<sup>l</sup> 'Metabolically active' fat is closely associated with insulin resistance, pre-diabetes and type 2 diabetes.

<sup>m</sup> Social deprivation was assigned using Indices of Multiple Deprivation (IMD) 2007.

Deprivation is associated with obesity, physical inactivity, unhealthy diet, smoking and poor blood pressure control.<sup>23</sup> All these factors are inextricably linked to the risk of diabetes or the risk of serious complications for those already diagnosed.<sup>37</sup>

## 6. What are the health implications of diabetes?

People with diabetes are at risk of a range of health complications including cardiovascular disease, blindness, amputation, kidney disease and depression

Diabetes leads to a two-fold excess risk for cardiovascular disease

Diabetic retinopathy is the leading cause of preventable sight loss in people of working age in England and Wales

Up to 100 people a week have a limb amputated in the UK as a result of diabetes

Depression is nearly twice as high among people with type 2 diabetes than in those without the condition

In England and Wales, diabetes is a major cause of mortality with over 23,300 additional deaths in 2010-11

Ninety percent of people with type 2 diabetes are overweight or obese and people with diabetes are at risk of a range of health complications. Uncontrolled diabetes is associated with cardiovascular disease (CVD), blindness, amputation, kidney disease and depression. It can also result in lower life expectancy. Life-long diabetes can also have a profound impact on lifestyle, relationships, work, income, and health and wellbeing.<sup>38</sup>

Analysis of the National Diabetes Audit (NDA) 2011-12 shows that people with diabetes in England are significantly more likely to experience myocardial infarction, angina, heart failure, stroke and to have renal replacement therapy or a lower limb amputation than the general population. (Table 2)

**Table 2:** Increased risk of diabetic complications in people with diabetes compared to the general population in England

Diabetic complication	Additional risk of complication among people with diabetes
Angina	+ 76%
Myocardial Infarction (heart attack)	+ 55%
Heart failure	+ 74%
Stroke	+ 34%
Renal Replacement Therapy (ESKD)	+ 164%
Minor Amputation (below the ankle)	+ 337%
Major Amputation (above the ankle)	+ 222%

Source: National Diabetes Audit 2011-12. Report 2: Complications and Mortality

Note: The calculations compare the prevalence for people with diabetes with the prevalence in the general population in the same Clinical Commissioning Group or Local Health Board during the period from 1 April 2010 to 31 March 2012, using the HES and PEDW records. Diabetic ketoacidosis (DKA) and retinopathy treatments are not included as these only affect people with diabetes.

However, whilst the additional risk of amputation and renal replacement therapy is higher than that of heart disease, many more people with diabetes have heart disease. (Table 3)

**Table 3:** Two year prevalence\* of diabetic complications for England and Wales in 2010-12

Complication	Number of people with diabetes experiencing the complication
Angina	117,278
Myocardial Infarction (heart attack)	28,812
Heart failure	81,452
Stroke	35,120
Renal Replacement Therapy (ESKD)	15,415
Minor Amputation (below the ankle)	5,869
Major Amputation (above the ankle)	3,319

\* Two year prevalence is the number of people with one or more complication event during the two years following the audit period (from 1 April 2010 to 31 March 2012).

Source: National Diabetes Audit 2011-12. Report 2: Complications and Mortality

## Cardiovascular Disease (CVD)

A meta-analysis by the Emerging Risk Factors Collaboration found that diabetes leads to a two-fold excess risk of CVD, (heart attack, heart failure, angina, stroke) independent from other risk factors.<sup>39</sup> National Diabetes Audit data show that people from South Asian ethnic groups are at greater risk of CVD compared to

those from white ethnic groups and people living in the most deprived quintile are over 50% more likely to experience cardiovascular complications compared with those living in the least deprived quintile. People with diabetes with a very high BMI ( $35\text{+kg/m}^2$ ) are over twice as likely as those with a lower BMI to have a hospital admission with heart failure in England.<sup>36</sup>

The National Cardiovascular Health Intelligence Network has recently produced a series of **factsheets**. These include information on cardiovascular risk factors and diabetes for commissioners and health and social care professionals.<sup>11</sup>

## Blindness

Diabetic retinopathy is the leading cause of preventable sight loss in the working age population of England and Wales.<sup>40</sup> It occurs as a result of damage to the small blood vessels in the retina caused by prolonged exposure to high blood glucose levels. Longer diabetes duration and poorer glycaemic and blood pressure control are strongly associated with diabetic retinopathy.<sup>41</sup>

Evidence of the association between diabetic retinopathy and obesity is inconclusive. Some studies suggest that obesity may be an independent risk factor for diabetic retinopathy and that people with diabetes with higher BMI are more likely to have diabetic retinopathy and more severe stages of diabetic retinopathy.<sup>42,43</sup> Others have concluded that higher BMI is associated with lower diabetic retinopathy prevalence.<sup>44</sup> This mixed evidence is likely to result from methodological differences between studies and the fact that the relationship between the two conditions is complex and associated with multiple risk factors.

## Amputation

In England, people with diabetes are twenty times more likely to undergo a lower extremity amputation compared with people without diabetes.<sup>45</sup> Up to 100 people a week have a limb amputated in the UK as a result of diabetes, and in many cases this is avoidable.<sup>46</sup> Men are over two times more likely to have a diabetes-related amputation than women and older people are at increased risk (1% increased risk per additional year of age). People from white ethnic groups are more likely to have had a major amputation than those from black and south Asian ethnic groups. Deprivation increases the risk of major amputation, with those living in the most deprived quintile over 80% more likely to have had an amputation than those in the least deprived quintile.<sup>36</sup>

## Chronic kidney disease

Obesity and type 2 diabetes contribute to the development and progression of chronic kidney disease (CKD<sup>n</sup>) and end stage renal disease.<sup>47</sup> Type 2 diabetes is a leading cause of end stage kidney disease; obesity may also increase the risk of kidney disease independent of type 2 diabetes.<sup>48</sup>

## Depression

Nearly one in five people with diabetes have clinical depression.<sup>49</sup> A recent systematic review found that depression was nearly twice as high in people with type 2 diabetes compared to those without the condition (19.1% compared to 10.7%), with higher rates among women than men.<sup>50</sup> However there is currently insufficient evidence to suggest a causal relationship between depression and diabetes.<sup>51</sup>

## Mortality

In England, diabetes is a major cause of mortality with around 23,300 additional deaths in 2011-12.<sup>36</sup> On average at age 50 years, the life expectancy of people with diabetes is six years less than for people without diabetes.<sup>52</sup>

Whilst type 2 diabetes is associated with an additional risk of death at all ages and in both sexes, the relative risk (by comparison to the general population) is greatest at younger ages and in women. Deprivation also increases the risk of mortality among people with type 2 diabetes, with those from the most deprived quintile 35% more likely to die than those in the least deprived quintile.<sup>36</sup>

Evidence on how overweight and obesity affect mortality in people with diabetes is unclear. A large-scale longitudinal study of people diagnosed with diabetes found that BMI was associated with risk of death, with healthy-weight participants at lowest risk.<sup>53</sup> In addition, a pooled analysis of prospective cohort studies revealed that people aged 35-59 years with severe obesity (BMI of 40-50kg/m<sup>2</sup>) were 22.5 times more likely to die from diabetes than those with BMI between 22.5-25kg/m<sup>2</sup>.<sup>54</sup> However National Diabetes Audit data suggest that a BMI of 25kg/m<sup>2</sup> and over is associated with lower mortality in people with type 2 diabetes compared to those of a healthy weight.<sup>36</sup>

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<sup>n</sup> CKD is a long-term complication of diabetes. CKD has five stages or levels of damage and reduced kidney function. CKD5 (Kidney failure or End Stage Renal Failure, ESRF) will cause death without Renal Replacement Therapy (RRT – dialysis or transplantation).

## 7. What are the cost implications of obesity and diabetes?

It is estimated that overweight, obesity and related morbidity will cost the NHS £9.7 billion by 2050 with wider costs to society estimated to reach £49.9 billion

Prescribing for diabetes accounted for 9.3% of the total cost of prescribing in England in 2012-13

It is estimated that in 2010-11 the cost of direct patient care for those living with type 2 diabetes in the UK was £8.8 billion and the indirect costs were approximately £13 billion

The number of NHS-commissioned bariatric surgery procedures performed for the management of obesity is increasing rapidly in England

In the UK, it is estimated that overweight, obesity and related morbidity cost the NHS £4.2 billion in 2007 and these costs are predicted to reach £9.7 billion by 2050. Wider total costs to society (such as loss of productivity) of overweight and obesity are estimated to reach £49.9 billion by 2050.<sup>8</sup> Recent analysis of the Million Women Study<sup>o</sup> found that among women aged 50-84 years in England, around one in eight hospital admissions were attributable to overweight or obesity.<sup>55</sup>

The National Audit Office (NAO) reported that NHS expenditure on diabetes services in 2009-10 was at least £3.9 billion.<sup>56</sup> A recent economic study estimated that in 2010-11 the cost of treating type 2 diabetes and its associated complications in the UK was £8.8 billion and the indirect costs (such as loss of productivity due to increased death and illness and the need for informal care) were £13 billion. Modelled projections show that these costs could rise dramatically in the next few decades.<sup>57</sup> It has been estimated that the total cost of caring for people with diabetes in adult social care settings in England is £830 million per year.<sup>58</sup> It is likely that a substantial proportion of these social care costs are associated with excess weight.

The following section provides information on lifestyle interventions, prescribing and surgical interventions for type 2 diabetes and obesity and their associated costs.

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<sup>o</sup> The Million Women Study is a national study of women's health, involving more than one million UK women aged 50 years and over. It is a collaborative project between Cancer Research UK and the National Health Service, with additional funding from the Medical Research Council and the Health and Safety Executive.

## Lifestyle interventions

Intensive lifestyle interventions have been found to delay or prevent progression from impaired glucose tolerance to type 2 diabetes<sup>59,60</sup> with evidence of long-term cost savings in the US.<sup>61</sup> In 2012, NICE produced a costing model associated with offering intensive lifestyle change programmes to people aged 40-74 years who are at highest risk of developing type 2 diabetes and also risk assessments, blood testing and interventions to people of South Asian or Chinese descent aged 25-39 years. They estimate that in England, the total cost of intensive lifestyle-change programmes is £170 million over five years, with savings of £13 million over the same period. Local costing templates have been produced to enable organisations to estimate local impact on implementing these interventions.<sup>30</sup>

## Prescribing for diabetes

Type 2 diabetes can often be managed initially with lifestyle changes and oral glucose-lowering drugs. Metformin<sup>p</sup> is the most commonly prescribed antidiabetic drug in England. NICE recommends starting metformin treatment in a person who is overweight or obese (tailoring the assessment of body-weight-associated risk according to ethnic group) and whose blood glucose is inadequately controlled by lifestyle interventions (nutrition and exercise) alone.<sup>62</sup> Metformin accounts for the greatest number of items prescribed for diabetes in England, with a growth of 97% between 2005-06 and 2012-13 and an increase in the Net Ingredient Cost (NIC)<sup>q</sup> rising from £37.1 million to £70.5 million during this period.<sup>63</sup>

Over time, many people with type 2 diabetes require insulin therapy to maintain adequate glucose control. Weight gain is a common adverse effect of insulin therapy with average increases in body weight between 2kg and 4kg.<sup>63</sup> In 2012-13 the NIC of insulin items prescribed in England was £320 million, an increase of £100 million since 2005-06.<sup>63</sup> Between 1991 and 2010 there was a seven-fold increase in the number of people with type 2 diabetes using insulin in the UK. This rise is likely to reflect the increasing incidence, longer survival and changes in the management of type 2 diabetes.<sup>64</sup>

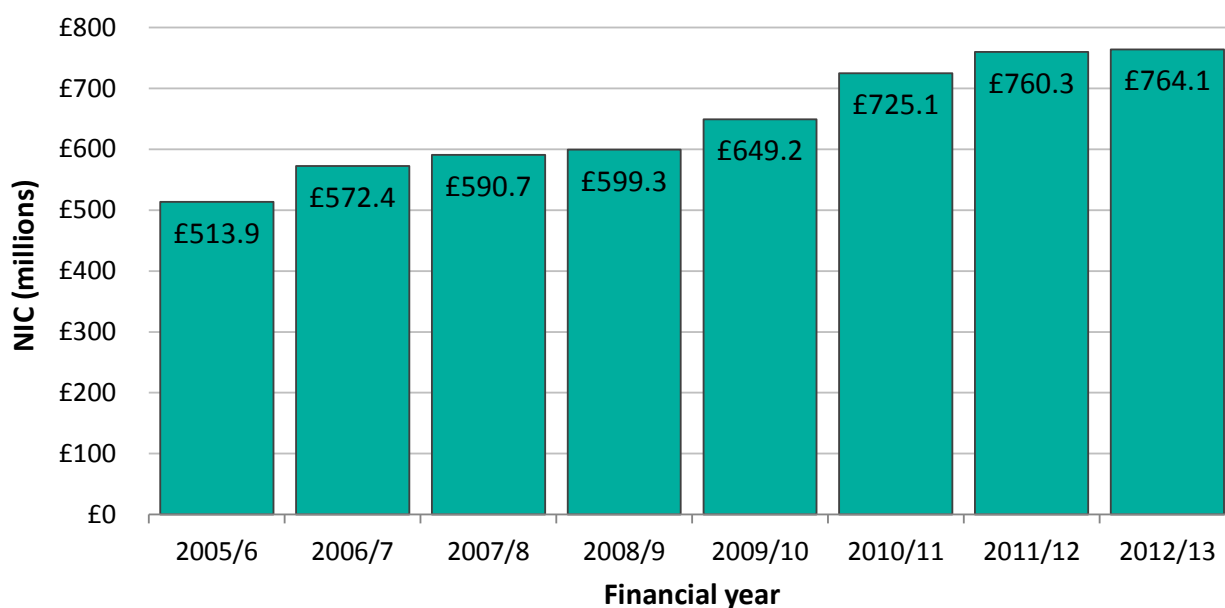
In 2012-13 total prescribing for all types of diabetes (as defined in British National Formulary 6.1) accounted for 9.3% of the total cost of prescribing in England. Between 2005-06 and 2012-13, the total NIC for diabetes prescribing increased by 48.7% (£250.2 million) to £764.1 million, compared with a growth of 6.6% for all prescribing over the same period.

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<sup>p</sup> Metformin is a diabetes drug known as a biguanide. It reduces the amount of glucose produced by the liver and kidneys and makes cells in the body take up glucose more effectively from the blood.

<sup>q</sup> The Net Ingredient Cost (NIC) is the basic cost of the drug, not taking into account discounts, dispensing costs, fees or prescription charges income.

**Figure 8:** Net Ingredient Cost (NIC) for drugs used to treat diabetes (BNF 6.1),\* 2005-06 to 2012-13



Source: ePACT, Health and Social Care Information Centre, Prescribing for Diabetes, England 2005-06 to 2012-13

\*Includes insulin and drugs to help control blood sugar levels

### Bariatric surgery<sup>f</sup>

A recent systematic review and meta-analysis found that bariatric surgery leads to greater weight loss and higher remission rates of type 2 diabetes and greater reductions in use of antidiabetic, antihypertensive and lipid lowering drugs compared with non-surgical treatment for obesity. However, results were limited to two years of follow-up and based on a small number of studies and individuals.<sup>65</sup> A further systematic review concluded that bariatric surgical procedures in people with diabetes and a BMI of 30-35 were associated with greater short-term weight loss and better intermediate glucose outcomes compared to nonsurgical treatments, although evidence on long-term outcomes was lacking.<sup>66</sup> NICE is currently consulting on its guideline on the identification, assessment and management of overweight and obesity. It includes draft recommendations on bariatric surgery for people with recent onset type 2 diabetes and is due to be published in November 2014.

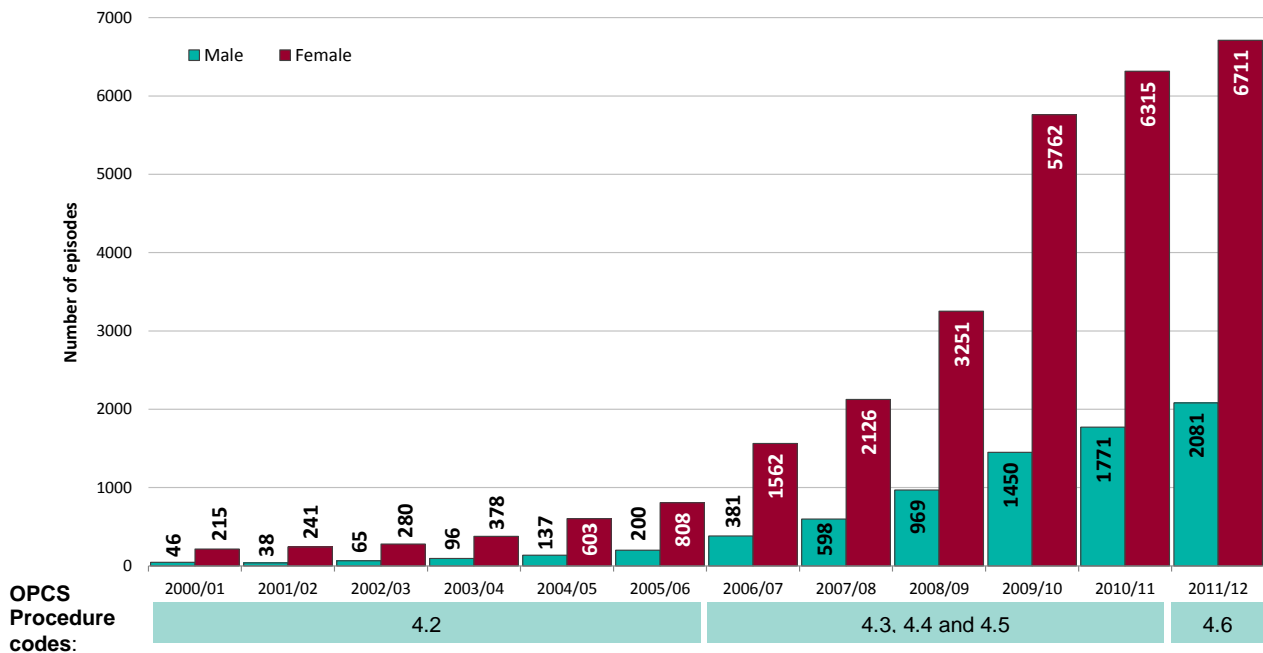
The number of NHS-commissioned bariatric surgery procedures performed for the management of obesity is increasing rapidly in England. Between 2000/01 and

<sup>f</sup> Bariatric surgery is a term that describes a group of procedures performed to facilitate weight loss. It includes gastric banding, gastric bypasses and sleeve gastrectomy. NICE guidance supports the use of bariatric surgery as a treatment option for adults with a BMI of 40kg/m<sup>2</sup> or more, or between 35kg/m<sup>2</sup> and 40kg/m<sup>2</sup> and other significant disease (such as type 2 diabetes) that could be improved if they lost weight. The patient must also fulfill a number of additional criteria.



2005/06 there was a year on year increase in the number of hospital episodes involving bariatric surgery, from 261 to 1,038. In 2011-12 this had risen to 8,794 hospital episodes, with women accounting for the majority of these (6,711 compared to 2,081 in men).<sup>s,67</sup>

**Figure 9:** Number of hospital episodes for bariatric surgery in England by sex, 2000/01 to 2011/12\*



Source: Health and Social Care Information Centre. Statistics on Obesity, Physical Activity and Diet: England, 2013

\*Results based on the old OPCS procedure codes coding cannot be compared with results based on the revised systems

### Economic assessment of adult weight management<sup>t</sup> interventions

PHE has developed a [tool](#) to support public health professionals to understand the economic case for investing in weight management interventions. The tool is intended primarily to be used by local commissioners who wish to estimate the cost effectiveness of existing or planned interventions to inform commissioning decisions. It assesses potential reductions in healthcare costs as a result of reduced BMI from interventions, allowing comparison with the costs incurred. The tool provides results broken down by condition, so it is possible to use it to determine what savings in terms of diabetes treatment will result from a drop in the BMI of a given population. In most situations the tool seems to suggest that the

<sup>s</sup> This increase is likely to be partly due to changes in surgical practice rather than simply as a result of increasing obesity.

<sup>t</sup> The term weight management is broadly interpreted to include not just traditional weight management programmes, but also policy actions, environmental change, educational programmes or any other public health action leading to measured change in weight among a defined population.

biggest savings will result from preventing cases of diabetes rather than other diseases, although the relative proportion of savings by disease does vary depending on factors such as the age of the population, their starting BMI and how much weight loss is achieved.

## 8. Conclusion

Obesity and type 2 diabetes both present significant public health challenges. The link between the two conditions is important because obesity substantially increases the risk of type 2 diabetes. Type 2 diabetes is a major cause of premature mortality and contributes to a range of long-term health conditions including cardiovascular disease and microvascular complications including eye disease, foot disease and chronic kidney disease. People living in deprived areas and some minority ethnic groups are at particularly high risk of developing type 2 diabetes. The prevalence of both obesity and type 2 diabetes continue to rise in England, along with associated direct patient care costs and wider costs to society.

The purpose of this paper is to describe the relationship between obesity and type 2 diabetes and not to review treatment options. The latest public health and clinical guidelines on preventing and treating type 2 diabetes and obesity are included in the appendix, along with useful resources to help improve local services.

## 9. Appendix

### 1. National guidelines

The 2012 NICE public health guidance [Preventing type 2 diabetes: risk identification and interventions for individuals at high risk](#), recommends that GPs and other primary healthcare professionals use the [diabetes risk score assessment tool](#) for identifying people at risk of developing type 2 diabetes.

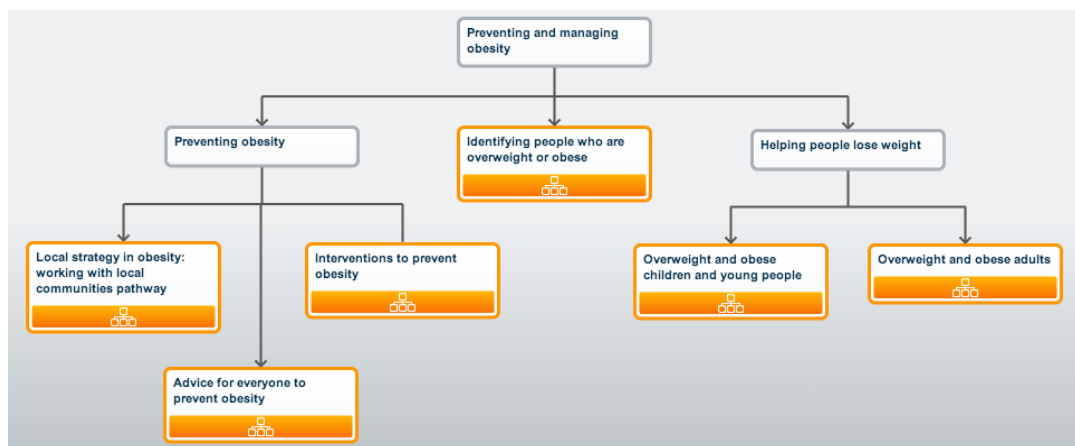
NICE has produced a series of guidance documents related to [diabetes prevention and treatment](#). In 2011 NICE published a [quality standard for the clinical management of diabetes in adults](#) which requires services to be commissioned from and coordinated across all relevant agencies encompassing the whole [diabetes care pathway](#). It supports the Department of Health's [National Service Framework for Diabetes](#) and promotes an integrated approach to provision of services and locally agreed pathways of care. NICE have also published guidance

on preventing type 2 diabetes in the general population and among high-risk groups aimed at directors of public health, public health commissioners and all those working in national and local public health services. The guidance is underpinned by previous NICE recommendations on supporting behaviour change, achieving and maintaining a healthy weight, effective weight-loss programmes, physical activity and cultural appropriateness. Further guidance on risk identification and interventions for individuals at high risk has also been produced.

NICE clinical guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children was published in 2006.

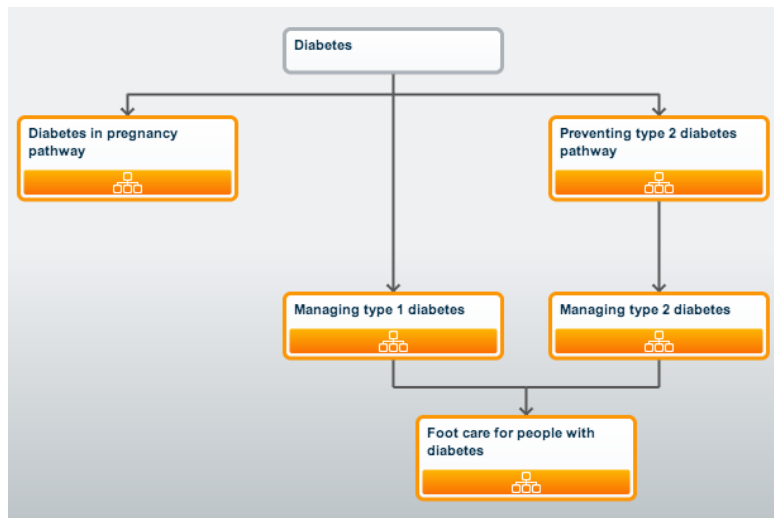
The easiest way to navigate these and other guidance documents is via the two interactive pathways for obesity and diabetes:

**Figure 10:** NICE Obesity pathway



National Institute for Health and Care Excellence (2014) NICE Obesity pathway. Manchester: NICE. Available from <http://pathways.nice.org.uk/pathways/obesity> Reproduced with permission.

**Figure 11:** Diabetes pathway

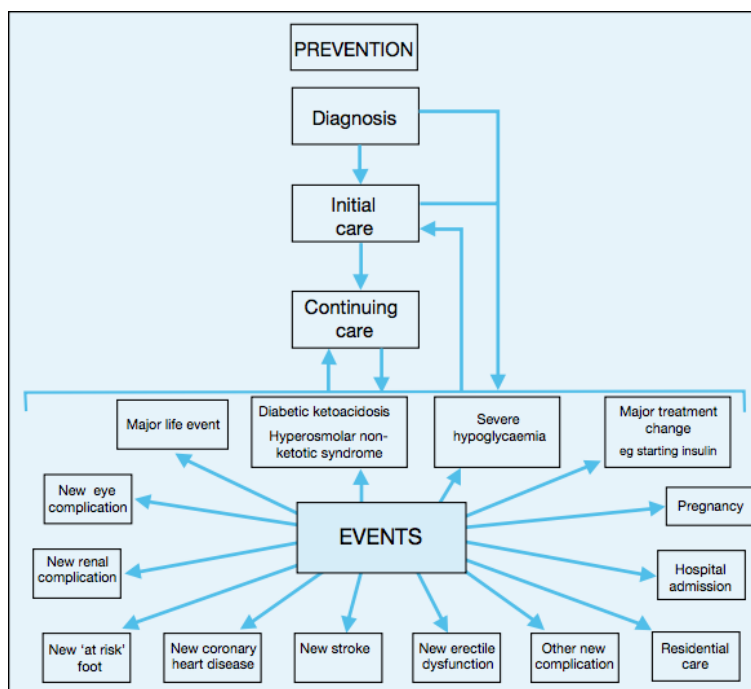


National Institute for Health and Care Excellence (2014) NICE Diabetes pathway. Manchester: NICE. Available from <https://pathways.nice.org.uk/pathways/diabetes> Reproduced with permission.

### Prevention and management of diabetes

The following diagram summarises the National Service Framework (NSF) for Diabetes pathway for the prevention and management of diabetes. It depicts prevention through to continuing care, specific events and complications.

**Figure 12:** Diabetes pathway for the prevention and management of diabetes



Source: National Service Framework for Diabetes, 2001

## 2. Mandatory data collection

### Public Health Outcomes Framework (PHOF)

From April 2013, local authorities have been paid a health premium for the progress they make against indicators set out in the [Public Health Outcomes Framework for England, 2013-2016](#). Domain 2 (health improvement) includes indicators on excess weight, diabetes, diet and physical activity among adults.

### Quality and Outcomes Framework (QOF)

The [Quality and Outcomes Framework \(QOF\)](#) is a voluntary annual reward and incentive programme for all GP practices in England. Current QOF prevalence figures are not age adjusted, are reliant on practice compliance, and do not capture non registered or non-attending patients.

The QOF 2012-13 clinical register on obesity is based on patients aged 16 years and over with a BMI greater or equal to 30 recorded in the previous 15 months. The clinical register on diabetes is based on patients aged 17 years and over with confirmed diabetes and diabetes type. It includes a range of indicators for the ongoing management of diabetes and includes the percentage of patients with diabetes whose notes record BMI in the preceding 15 months.

NICE is currently consulting on a 'bundled' QOF indicator on diabetes for 2015-16, which would see practices being required to complete a series of eight annual checks (including BMI measurement) before they are awarded points.

## 3. Useful resources

A number of resources have been produced to help improve local services. For example, the DH Health Inequalities National Support Team (HINST) developed a workbook on the [Assessment of Services to Reduce Diabetes-related Mortality](#) which provides advice on achieving best outcomes at population level as well as changes that could be introduced locally. [Implementing local diabetes networks](#) by NHS Diabetes and Diabetes UK provides advice for diabetes commissioners on how to create establishing a local diabetes network in their area.

The Royal College of Nursing's [Diabetes resource](#) signposts key sources of information for diabetes care.

National service frameworks		
Department of Health	2003	<a href="#">Diabetes Information Strategy</a>
Royal College of Nursing	2003	<a href="#">An RCN guide to the National Service Framework for Diabetes</a>
Department of Health	2002	<a href="#">National Service Framework for diabetes: Delivery strategy</a>
Department of Health	2001	<a href="#">National Service Framework for Diabetes</a>

National clinical guidelines and standards		
NICE	2014	Local government briefing: Body mass index thresholds for intervening to prevent ill health among black, Asian and other minority ethnic groups
NICE	2013	PH46: BMI and waist circumference – black, Asian and minority ethnic groups
NICE	2013	PH44: Physical activity: brief advice for adults in primary care
NICE	2013	Local government briefing: Preventing obesity and helping people to manage their weight
NICE	2012	PH38: Preventing type 2 diabetes: risk identification and interventions for individuals at high risk
NICE	2012	PH42: Obesity: working with local communities
NICE	2012	Public health briefings for local government: physical activity and workplace health behaviour change and walking and cycling
NICE	2012	Walking and cycling: local measures to promote walking and cycling as forms of travel or recreation
NICE	2011	Diabetes in adults quality standard (QS6)
NICE	2011	PH35: Preventing type 2 diabetes – population and community interventions: guidance
NICE	2009	CG87 Type 2 Diabetes: The management of type 2 diabetes (Partial update of CG66).
NICE	2008	CG66: Type 2 diabetes: The management of type 2 diabetes
NICE	2006	CG43: Obesity: Guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children
NICE	2004	CG15: Type 1 diabetes: Diagnosis and management of type 1 diabetes in children, young people and adults
Other resources		
SACN	2014	Carbohydrates and Health
NHS England	2014	Action for diabetes
Diabetes UK	2014	State of the nation 2013
National Cardiovascular Intelligence Network (NCVIN)	2014	Strategic clinical network profiles: diabetes
Academy of Royal Medical Colleges	2013	Measuring up
Diabetes UK	2013	State of the nation
Health and Social Care Information Centre	2013	Prescribing for diabetes in England: 2005-06 to 2012-13
Royal College of Physicians	2013	Action on obesity: Comprehensive care for all
National Diabetes Information Service (now part of NCVIN)	2013	Comprehensive range of diabetes data, tools and information via one web portal
Diabetes UK	2012	The NHS Health Check Programme – Let's Get It Right
Diabetes UK	2012	Position statement: Early identification of people with Type 2 diabetes
Diabetes UK	2012	Position statement: Prevention of Type 2 diabetes: reducing risk factors
House of Commons Public Accounts Committee	2012	Seventeenth report: Department of Health: The management of adult diabetes services in the NHS
NHS Diabetes and Diabetes UK	2012	Implementing local diabetes networks
Atlas of Variation in Healthcare for People with Diabetes	2012	<a href="http://www.rightcare.nhs.uk/index.php/atlas/diabetes/">http://www.rightcare.nhs.uk/index.php/atlas/diabetes/</a>
Association of British Clinical Diabetologists	2011	Position statement: physical activity and exercise in diabetes
Department of Health	2011	Health Inequalities National Support Team. Assessment of Services to Reduce Diabetes-related Mortality
Diabetes UK	2011	Evidence-based nutrition guidelines for the prevention and management of diabetes
International Diabetes Federation Taskforce on Epidemiology and Prevention of Diabetes	2011	Bariatric surgery: an IDF statement for obese Type 2 diabetes

NHS Diabetes	2011	Commissioning Diabetes Prevention and Risk Assessment Services
SACN	2011	SACN Dietary Recommendations for Energy report
NHS Diabetes	2010-11	Diabetes commissioning guides
Scottish Intercollegiate Guidelines Network	2010	Management of obesity: (SIGN Guideline number 115)
Scottish Intercollegiate Guidelines Network	2010	Management of diabetes (SIGN Guideline number 116)
NICE	2010	NICE public health guidance: Weight management before, during and after pregnancy. Dietary interventions and physical activity interventions for weight management before, during and after pregnancy
NICE	2008	NICE Physical activity and environment: guide to resources
NICE	2008	NICE public health guidance: Physical activity and the environment
Department of Health and Diabetes UK Care Planning Working Group	2006	Care Planning in Diabetes
NICE	2006	NICE public health guidance: Physical activity: Four commonly used methods to increase physical activity: brief interventions in primary care, exercise referral schemes, pedometers and community-based exercise programmes for walking and cycling

## 4. Measures of obesity

### Body mass index (BMI)

The most common measure of weight status is BMI, defined as weight in kilograms divided by the square of height in metres. Conventional adult BMI classifications relating to excess weight are 'overweight' (25.0-29.9kg/m<sup>2</sup>) and 'obese' (30.0kg/m<sup>2</sup> and above). These thresholds were originally derived primarily for European populations to correspond to risk thresholds for a wide range of chronic diseases and mortality. BMI is not a direct measure of body fat mass or distribution, and BMI measures may be skewed by very high muscle mass.

It is now generally accepted that people from black, Asian and other minority ethnic groups are at greater risk of type 2 diabetes and other health conditions at lower BMI levels than white European populations. NICE recommends using lower thresholds (23kg/m<sup>2</sup> to indicate increased risk and 27.5kg/m<sup>2</sup> to indicate high risk) for BMI to trigger action to prevent type 2 diabetes among Asian (South Asian and Chinese) and the extending of these thresholds to black African and African-Caribbean populations.<sup>33</sup>

### Waist circumference (WC)

WC is a measure of the accumulation of body fat around the waist (central or abdominal adiposity) and may present a greater risk to health than fat deposited in other parts of the body. High levels of central adiposity in adults is known to be associated with increased risk of obesity-related conditions including type 2

diabetes, hypertension and heart disease. Although measures of central adiposity are closely correlated with BMI, they have been shown to predict future ill health independently of BMI.<sup>68</sup> Current WC thresholds for increased risk of obesity-related health problems among white populations are 94cm or more in men, and 80cm or more in women. The equivalent thresholds for greatly increased risk are 102 cm for men and 88cm for women.<sup>69</sup>

There is evidence that people of South Asian origin have a more centralised distribution of body fat without necessarily developing generalised obesity and show raised obesity-related risk at lower waist circumference levels.<sup>70,71</sup> The International Diabetes Federation and South Asian Health Foundation are in agreement that the healthy WC threshold for men from South Asian and Chinese ethnic groups should be reduced from 94cm to 90cm, to indicate increased risk. No change from 80cm has been recommended for women.<sup>72</sup>

A recent literature review concluded that optimal WC threshold values vary across different ethnicities and there is no universal optimal value that can be applied worldwide, although country or region-specific threshold values could be considered.<sup>73</sup> As there are no globally applicable WC thresholds as yet, NICE does not recommend separate WC thresholds for different ethnic groups in the UK.<sup>74</sup>

## 5. Data sources

### Diabetes Prevalence Model for local authorities in England

The Diabetes Prevalence Model for local authorities in England, developed by YPHO, provides modelled estimates of diabetes prevalence by local authority. It updates the Diabetes Prevalence Model (APHO) to reflect the prevalence of diabetes (diagnosed and undiagnosed) and the distribution of BMI found in the 2010 Health Survey for England. Calculations have been included to show the potential impact of the increasing prevalence of overweight and obesity on diabetes prevalence.

### National Diabetes Audit (NDA)

The NDA is the largest annual clinical audit in the world, integrating data from both primary and secondary care sources in England and Wales. The NDA is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part

of the National Clinical Audit and Patient Outcomes Programme (NCAPOP), and delivered by the Health and Social Care Information Centre, working with Diabetes UK. See <http://www.hscic.gov.uk/nda>



## Health Survey for England (HSE)

The HSE is an annual survey undertaken since 1991. The HSE is commissioned by the Health and Social Care Information Centre (and before 2005 was commissioned by the Department of Health) to monitor the health of the population. This is currently the most robust data source to monitor trends in adult obesity in England.

## Active People Survey (APS)

The APS is a large telephone survey of sport and active recreation, commissioned by Sport England. The survey measures participation in sport and active recreation, and provides details of how participation varies from place to place and between different groups in the population. The survey began in October 2005, and is repeated annually.

## 6. Search strategy

A search was conducted on Medline, Embase, Psychinfo, Cochrane, TRIP and NHS Evidence, limited to English language and the last five years for obesity and diabetes. The full Medline search strategies are listed below:

#1 Diabetes mellitus\ explode

#2 body mass index\ or waist-circumference\ or waist-hip ratio\ or WHR or Dexa or bio-impedance or obesity\ or overweight\ or weight\ or diet\ or “fat mass” or diabetes or diabetogenic or “skin fold thickness” or adiposity\ or body fat distribution\ or weight gain\

#3 #1 and #2

Limit to published after 2009

#1 diabetes mellitus\

#2 Socio economic factors\ {includes poverty, inequalities, social class or ethnic groups\ or age factors\

#3 motor activity\ or physical fitness\ or activities of daily living\ or physical exertion\ or exercise\ or sedentary lifestyle\

#4 #1 and #2

#5 #1 and #3

Limit to published after 2009

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## Reader information

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