Certification of deaths from diabetes mellitus and obesity in England: trends into the twenty-first century

Marie E. Duncan, Michael J. Goldacre

Unit of Health-Care Epidemiology, Department of Public Health, University of Oxford, Old Road Campus, Oxford OX3 7LF, UK
Address correspondence to Michael Goldacre, E-mail: michael.goldacre@dph.ox.ac.uk

ABSTRACT

Background Most cases of Type 2 diabetes are attributable to excess weight and physical inactivity. We investigated trends in mortality based on doctors’ certification of diabetes and obesity.

Methods Analysis of a national data set of all certified causes of death, i.e. underlying cause and contributing causes (‘mentions’), in England 1995–2010.

Results Diabetes exhibited divergent trends for mortality based on underlying cause and mentions. Underlying cause rates were 107.2 per million population [95% confidence interval (CI): 105.7–108.6] in 1995, but only 68.9/106 (CI: 67.9–69.9) in 2010. Mortality rates for mentions of diabetes were 403.1/106 (CI: 400.4–405.8) in 1995, increasing to 478.4/106 (CI: 475.7–481.0) in 2010. Underlying cause mortality for obesity was 3.7/106 (CI: 3.2–4.1) in 1995 and 7.5 (CI: 7.0–8.0) in 2010. The corresponding rates for mentions of obesity were 13.2/106 (CI: 12.6–13.9) and 34.5/106 (CI: 33.6–35.4), respectively. 24.0% of death certificates with a mention of obesity also had diabetes recorded on the same certificate.

Conclusions Multiple-cause mortality statistics provide a more accurate picture than underlying cause of the total mortality burden attributed on death certificates to diabetes and obesity. Rates for both increased substantially: analysis by underlying cause alone would have missed this for diabetes.

Keywords death certification, diabetes, England, mortality, obesity

Introduction

Obesity is a global epidemic with more than 1 billion adults overweight, and a third of these classified as clinically obese. Increased consumption of energy-dense, nutrient-poor foods containing high levels of sugar and saturated fats, combined with reduced physical activity, have led to obesity rates that have risen 3-fold or more since 1980 in some areas of North America, the UK, Eastern Europe, the Middle East, the Pacific Islands, Australasia and China. In England, the number of hospital admissions, procedures and prescriptions related to obesity continues to increase. The number of admissions related to obesity increased by 32% between 2008/09 (7988) and 2009/10 (10 571); bariatric weight-loss procedures increased by 70% (4221 in 2008/09 to 7214 in 2009/10) and the number of prescription items dispensed specifically to combat obesity was 1.45 million in 2009, an 11-fold increase when compared with 1999 (127 000).

Indeed, the problem of rising levels of obesity in the UK has become so acute that the Academy of Royal Medical Colleges launched a 3-month evidence-gathering enquiry in April 2012 with the aim of offering a series of practical recommendations for how the medical profession, individuals, organizations and Government can ensure an effective and coherent approach to reducing obesity levels. Obesity and overweight present a major risk for serious diet-related chronic diseases, including Type 2 diabetes. Most cases of Type 2 diabetes are attributable to excess
weight and physical inactivity, and Type 2 diabetes represents 90% of cases of diabetes worldwide.\(^4\) In addition to causing overt disease, obesity and the associated metabolic syndrome result in impaired glucose tolerance.

Death certification requires specification of the underlying cause of death, together with listing of any causes considered by the certifying doctor to have contributed to death. National mortality statistics for England are based on coded, computerized information obtained from death certificates. Although historically only the underlying cause of death was coded, since the mid-1990s, developments in information technology have allowed inclusion of contributing causes of death in the national database of mortality records.

We have previously published on mortality for diabetes in the former Oxford National Health Service (NHS) region from 1979 to 1999 using multiple-cause data (collected for the Oxford record linkage study from 1979.\(^5\)) We have also published on mortality for obesity in England up to 2006.\(^6\) However, the scale of change in mortality attributed to both has been so great recently that we now provide updated trends for each condition individually, together with the trend in mortality for diabetes and obesity co-recorded on the same death certificate.

**Method**

A file of coded, anonymized, death certificate data for England was supplied by the Office for National Statistics. This data set comprises all causes of death, contributing causes as well as the underlying cause, registered between January 1995 and June 2011. Since a proportion of deaths occurring towards the end of each calendar year is not registered until the next year, we restricted the analysis to deaths that had occurred in 1995–2010 (including those that had not been registered until the first 6 months of 2011). The data sets were searched for mentions of diabetes mellitus [International Classification of Diseases (ICD)-9 250 and ICD-10 E10–E14], obesity (ICD-9 278.0; and ICD-10 E66) and mentions of both conditions on the same death certificate, for the period 1995–2010.

The calculation of age standardized mortality rates with 95% confidence intervals for individual calendar years, and for the period 1995–2010, was based on age-specific mortality rates in 5-year age groups (0–4, 5–9...70–74, 75+). Standardization was performed using the direct method by applying the age-specific rates in each 5-year age group, in each calendar year, to the European standard population. An average annual percentage change (AAPC) in mortality rates based on underlying cause and mentions was calculated by fitting linear regression models to the logarithms of the death rates for each individual calendar year, for the period 1995–2000 (ICD-9) and 2001–10 (ICD-10). The number of deaths coded as underlying cause was expressed as a percentage of all mentions for each condition.

**Results**

**Trends in death certification of mortality for diabetes**

There were 406 164 deaths with a mention of diabetes in the period 1995–2010 (204 919 men, 201 245 women). This represents 5.1% (406 164/7 943 172) of all deaths in England. Overall, diabetes was coded as the underlying cause of death on 21.3% of death certificates where it was mentioned. The percentage of deaths recorded as the underlying cause was much higher in younger age groups. For example, in men and women aged 15–34, respectively, 56.8 and 51.4% of death certificates with diabetes had it recorded as the underlying cause.

There were divergent trends for underlying cause and mentions mortality for diabetes (Fig. 1). Underlying cause rates were 107.2 per million [95% confidence interval (CI): 105.7–108.6] in 1995, 96.4/106 (CI: 95.1–97.7) in 2001 and they fell to 68.9/106 (CI: 67.9–69.9) in 2010. The AAPC for the period 2001–10 was \(-2.4.0\%\) (CI: \(-2.4.6\) to \(-2.3.4\)). Mortality rates based on mentions were 403.1/106 (CI: 400.4–405.8) in 1995, 399.1/106 (CI: 396.5–401.7) in 2001 and they increased...
to 478.4/10^6 (CI: 475.7–481.0) in 2010. This represented an average annual percentage increase of 2.0% (CI: 1.6–2.4) between 2001 and 2010 (Table 1).

Between 2001 and 2010 the largest average annual decreases in underlying cause mortality were seen in men and women aged 65–74 years, at 7.3% (CI: 6.2–8.4) and 7.7% (CI: 6.0–9.4), respectively. The largest average annual increases in mentions mortality for diabetes occurred in those aged 75 years and over, at 3.0% (CI: 2.6–3.4) for men and 3.1% (CI: 2.6–3.6) for women. The AAPC in mentions mortality was also significantly high for women aged 45–54 years at 3.1% (CI: 1.2–5.1) (Table 1).

**Trends in death certification of mortality for obesity**

There were 14,285 deaths with a mention of obesity (5744 men, 8541 women) between 1995 and 2010. Numbers were very similar for men and women up to age 54. From age 55 there was an increasing excess of deaths in women: at age 75 years and over there were 670 obesity deaths in men and 2399 in women. This excess remains after adjusting for the differences in population size between men and women of this age, i.e. about 1.5 females for every one male. Obesity was recorded as the underlying cause of death on approximately a quarter (23.2%) of death certificates where it was mentioned in 1995–2010.

Mortality for mentions of obesity increased slightly between 1995 and 2000 (Fig. 2), but between 2001 and 2010 there was a very substantial increase in deaths with a mention of obesity. (Note the use of different scales in Figs 1–3 when comparing the magnitude of mortality trends.) Mortality rates per million for mentions of obesity were 13.2 (CI: 12.6–13.9) in 1995, 14.9 (CI: 14.2–15.6) in 2001 and 34.5 (CI: 33.6–35.4) in 2010. The AAPC in mortality between 2001 and 2010 was 10.3% (CI: 9.2, 11.3) per year. Underlying cause mortality rates doubled over the same period from 3.7/10^6 (CI: 3.4–4.4) (2001) to 7.5/10^6 (CI: 7.0, 8.0) (2010), with an AAPC of 7.3% (CI: 5.9–8.7).

**Mentions of both obesity and diabetes on the same death certificate**

The number of death certificates with a mention of both conditions on the same certificate increased almost 5-fold between 1995 and 2010: the AAPC was 16.7% (CI: 14.3, 19.2) over the period 2001–10 (Fig. 3, Table 1). Overall, almost a quarter (24.0%, 3427/14,285) of deaths with a mention of obesity were also mentioned as diabetes, and in nearly a quarter (23.8%, 3387/14,285) of death certificates both conditions were mentioned.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Diabetes</th>
<th>Obesity</th>
<th>Diabetes and obesity: same certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n MR AAPC (95% CI)</td>
<td>n MR AAPC (95% CI)</td>
<td>n MR AAPC (95% CI)</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15–34</td>
<td>645</td>
<td>9.4</td>
<td>1.1 (−3.0, 5.2)</td>
</tr>
<tr>
<td>35–44</td>
<td>1760</td>
<td>46.4</td>
<td>0.7 (−1.3, 2.7)</td>
</tr>
<tr>
<td>45–54</td>
<td>4990</td>
<td>154.5</td>
<td>1.4 (0.2, 2.6)*</td>
</tr>
<tr>
<td>55–64</td>
<td>14064</td>
<td>488.2</td>
<td>1.2 (0.0, 2.4)*</td>
</tr>
<tr>
<td>65–74</td>
<td>35210</td>
<td>1729.2</td>
<td>0.5 (0.0, 1.0)*</td>
</tr>
<tr>
<td>75+</td>
<td>82217</td>
<td>5545.7</td>
<td>3.0 (2.6, 3.4)*</td>
</tr>
<tr>
<td>Total ≥15</td>
<td>138886</td>
<td>547.9</td>
<td>1.9 (1.5, 2.4)*</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15–34</td>
<td>497</td>
<td>7.4</td>
<td>0.5 (−4.2, 5.4)</td>
</tr>
<tr>
<td>35–44</td>
<td>1051</td>
<td>27.4</td>
<td>1.5 (−1.1, 4.2)</td>
</tr>
<tr>
<td>45–54</td>
<td>2699</td>
<td>81.9</td>
<td>3.1 (1.2, 5.1)*</td>
</tr>
<tr>
<td>55–64</td>
<td>7930</td>
<td>265.7</td>
<td>0.6 (−0.9, 2.0)</td>
</tr>
<tr>
<td>65–74</td>
<td>23278</td>
<td>1016.8</td>
<td>−0.4 (−0.9, 0.1)</td>
</tr>
<tr>
<td>75+</td>
<td>97779</td>
<td>3773.1</td>
<td>3.1 (2.6, 3.6)*</td>
</tr>
<tr>
<td>Total ≥15</td>
<td>133234</td>
<td>344.5</td>
<td>1.8 (1.4, 2.3)*</td>
</tr>
<tr>
<td>Total ≥15</td>
<td>272120</td>
<td>433.0</td>
<td>2.0 (1.6, 2.4)*</td>
</tr>
</tbody>
</table>

The total number of mention deaths in England 2001–10 is 4 773 222.

* Rates are age standardized, overall and within each broad age stratum, in 5-year groups.

* Statistically significant change.
mention of obesity also had diabetes recorded on the death certificate. Between 1995 and 2000 17.0% of deaths with a mention of obesity also had diabetes recorded on the death certificate, and this increased to 26.3% for the period 2001–10.

Discussion

Main findings of this study

There were divergent trends for mortality rates for diabetes based on underlying cause or mentions. During the period 2001–10 there was a decline in underlying cause mortality, but an increase in mentions. There was a large rise in mortality rates for obesity, both as certified mentions and as underlying cause. The rise in mentions was steeper than that for underlying cause. There was also a steep rise in death certification rates with both diabetes and obesity on the same death certificate. Analysis of both obesity and diabetes on the same death certificate showed that a quarter of obesity deaths were associated with diabetes.

What is already known on this topic

Diabetes and obesity both present major public health challenges, and the prevalence of both is increasing in England and many other countries. Death certification underestimates the prevalence of each condition at death. Even with the inclusion of all certified causes of death, current death certificate practice is still considered to underestimate diabetes-related deaths. As part of the National Diabetes Audit (NDA) 2007–08, NDA records were linked to death registrations via the NHS Information Centre Medical Research Information Service. The authors estimated that the total number of deaths in people with diagnosed diabetes in England is 70–75 000 per year. Only a proportion of these had diabetes mentioned on their death certificate. Although the total number of deaths in people with diagnosed diabetes in England represented ~15% of the 460 000 deaths occurring annually in England in 2009, only 30 894 (6.7%) of all registered deaths included a mention of diabetes anywhere on the death certificate. Nonetheless, according to recent evidence almost half of deaths in individuals with diabetes are causally related to the disorder.

Obesity is not commonly certified as a cause of death on death certificates, but, since we last reported a large rise in the number of death certificates that included obesity in England, it seemed likely that the numbers have continued to increase. Despite the well-recognized limitations of mortality statistics, we considered it useful to study trends in doctors’ certification practice for both diabetes and obesity, separately and in combination.

What this study adds

Both obesity and diabetes were recorded as the underlying cause of death on less than a quarter of death certificates where these diseases were mentioned. The use of underlying cause mortality statistics alone would have missed the vast majority of deaths associated with obesity and diabetes.
leading to substantial underestimation of the mortality burden actually attributed to those conditions. The use of underlying cause mortality statistics alone would have missed the fact that, measured as mentions, mortality rates for diabetes have increased in recent years. It follows that, although diabetes is implicated in causing the deaths of increasing numbers of people, other co-morbid diseases are increasingly being certified as the underlying cause of death.

Mortality rates for both obesity and for diabetes, measured as mentions, have shown steep increases in recent years; and there has also been a sharp increase in mortality rates with both conditions recorded on the same death certificate.

Limitations of this study
We have no insights into trends in the practices of doctors in certifying deaths in people who die with diabetes or obesity. There is evidence that, when people die with a disease that is considered to be an ‘avoidable’ cause of death, clinicians may be disinclined to certify it as the underlying cause. It is possible that there has been an increase in reluctance to certify diabetes as an underlying cause and that this has contributed to the divergent trends between underlying cause and mentions. Another possible explanation is that, as the prevalence of diagnosed diabetes has increased, the proportion of diabetic people with mild-or-moderate disease has increased and that they are less likely to be regarded as having had life-threatening diabetes. A further explanation could be that, because of better control of diabetes, fewer people with diabetes are dying from illnesses regarded as being directly related to their condition. One possible explanation for the steep increase in mentions of diabetes could be increased awareness, and better recording, of the disease as a cause of death by certifying doctors.

Elsewhere we have discussed in detail the factors that may influence whether a certifying doctor records obesity on a death certificate; but it is clearly just a small minority of people who are in fact obese who have the condition certified as a cause of death.

Following recommendations of the Shipman Inquiry, a new system of death certification with the aim of improving the quality and accuracy of medical cause of death certificates and providing improved information on cause of death is being prepared, and, subject to Parliamentary approval, will be implemented in England and Wales in April 2014. It will be interesting to monitor the impact of the new system.

Acknowledgements
We would like to thank Myfanwy Griffith for extraction of specialized datasets; David Yeates and Matt Davidson for development of data extraction programmes; and Raph Goldacre for preparation of artwork.

Funding
This work was supported by the English National Institute for Health Research (Grant number RNC/035/002). The views expressed in this paper do not necessarily reflect those of the funding body.

References