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Identifying additional patients with diabetic nephropathy using the UK primary care initiative

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Abstract

Aims The aim of this study was to use general practice data to estimate the prevalence of diabetic nephropathy within the registered diabetes patients and examine variation in practice prevalence and management performance since introduction of this initiative.

Methods Reported quality indicators from the Northern Ireland General Practice Quality and Outcomes Framework were analysed for diabetes and diabetic nephropathy prevalence and management in the period 2004–2008. Variation in prevalence at practice level was assessed using multiple linear regression adjusting for age, practice size, deprivation and glycaemic control.

Results In 2006–2007, 57 454 (4.1%) adult diabetic patients were registered in the denominator population of 1.4 million compared with 51 923 (3.8%) in 2004–2005 (mean practice range 0.5–7.7%). Diabetic nephropathy prevalence was 15.1 and 11.5%, respectively (8688 and 5955 patients). Documented diabetic nephropathy prevalence showed marked variation across practices (range 0–100%) and was significantly negatively correlated with diabetes list size, albumin creatinine ratio testing rates and renin–angiotensin–aldosterone system blockade use and positively correlated with exception reporting rates. Specifically, for every increase in 100 diabetic patients to a register, documented diabetic nephropathy prevalence reduced by 40% (P = 0.003). On the positive side, median albumin-creatinine ratio testing rates doubled to 82% compared with figures in the pre-Framework era.

Conclusions Implementation of the Northern Ireland General Practice Quality and Outcomes Framework has positively benefitted testing for diabetic nephropathy and increased numbers of detected patients in a short space of time. Large variation in diabetic nephropathy prevalence remains and is associated with diabetes registry size, screening and treatment practices, suggesting that understanding this variation may help detect and better manage diabetic nephropathy.


Keywords albumin–creatinine ratio, chronic kidney disease screening, diabetic nephropathy, general practice, prevalence

Abbreviation QOF, Quality and Outcomes Framework

Introduction

The estimated prevalence of diabetic nephropathy is influenced by the precise age group studied, ethnicity and the force of co-morbidity and competing causes of death. A European cross-sectional study of Type 2 diabetic subjects calculated a prevalence of incipient nephropathy (microalbuminuria) of 27% and an additional 14% with overt nephropathy [1]. The National Health and Nutrition Examination Survey (NHANES) survey, a US population-based study of 14 000 randomly surveyed adults, documented an overall prevalence of 28.1 and 6.1% for incipient and overt nephropathy, respectively [2]. UK population-based studies have recognized lower prevalence rates for incipient and overt nephropathy at 19 and
6.8\%, respectively \[3,4\]. A more recent European study demonstrated reductions in prevalence rates since the 1980s, with improved diabetes and hypertension management \[5\].

The Quality and Outcomes Framework (QOF) is a pay-for-performance system for general practitioners and has established practice registers for each chronic disease rewarded (see also Supporting Information, Appendix S1 and Roland \[6\]). The aim of this study was to use QOF statistics to estimate the regional and the practice-based prevalence for diabetes and diabetic nephropathy for Northern Ireland. Furthermore, to examine differences in practice diabetic nephropathy prevalence using albumin-creatinine ratio testing rates, coexisting renin-angiotensin–aldosterone system blockade uptake, practice characteristics and exception reporting—any or all of which may be related to a practice’s approach to screening and managing diabetic nephropathy patients.

**Subjects and methods**

The crude diabetes-prevalence was calculated using the proportion of patients within each diabetes register to those in the practice list size. Only patients \(\geq 17\) years are included in the QOF diabetes registers. Therefore, the list size for each practice at the end of each financial year was initially corrected to include only those \(\geq 17\) years—giving more precise adult diabetes practice prevalence (Fig. 1).

Diabetic nephropathy has been defined in stages from microalbuminuria (also called incipient nephropathy) through to proteinuria (overt) in both Type 1 and Type 2 diabetic patients \[7,8\]. General practices use the national guidance [National Institute for Health and Clinical Excellence (NICE) and Scottish Intercollegiate Guidelines Network (SIGN)], which define diabetic nephropathy with an albumin-creatinine ratio \(> 2.5\) mg/mmol in men and \(> 3.5\) mg/mmol in women (the combination of incipient and overt nephropathy) \[9–11\].

This was taken from the denominator in QOF indicator 15 in the diabetes domain after re-inclusion of exception-reported patient numbers (see also Supporting Information, Appendix S1). Diabetic nephropathy prevalence was calculated proportional to the diabetes registry size. All prevalence estimates were calculated annually in financial years, in keeping with QOF recording.

Variation in prevalence rates were analysed for the 2005–2006 financial year—being the first year that exception-reporting statistics were available \[12\]. To protect patient identity, QOF results are not published for practices which have \(< 5\) patients in any group. Published exception reporting enables calculation of actual numbers with recorded nephropathy; however, this was not possible in the first year (2004–2005) so, for the first year, practices with less than 5 patients in the diabetes 15 denominator were not included (116 practices).

**Variables**

Previously, practices in highly deprived areas and with more diverse ethnicity had greater difficulty in achieving points in the QOF \[13\]. Also, subjects from Afro-Caribbean and Indo-Asian decent have a significantly greater risk of progressive diabetic nephropathy than Caucasians, despite achieving equivalent diabetes targets \[14\]. Northern Ireland has little ethnic diversity when compared with the rest of the United Kingdom. The 2001 census showed that 99.2% of the population are Caucasian, with the remaining \(< 1\%\) being from ethnic minority groups—the largest of these being Chinese (0.25%) \[15\]. Variation in prevalence of diabetic nephropathy is likely therefore to be related to organization and standards of care.

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**FIGURE 1** Data flow for prevalence calculations. *Practice median + interquartile range (IQR). QOF, Quality and Outcomes Framework.
Health is closely related to income in developed societies [16]. At practice level, an income score—-as a marker of material deprivation of the population served, was calculated for comparison between practices. Northern Ireland is divided into 5022 electoral output areas averaging 150 households. It is recognized that the patient list of each practice would cross the boundaries of different output areas, so using the postcode of where the practice itself is located may underestimate markers of deprivation and ill health [17]. Thus, a weighted mean income score for each practice population using patient level data was calculated. Counts of individuals living in each output area, in age bands per practice, were multiplied by that output area’s specific income score. Household income statistics were acquired from the Department of Health and Personal Social Services [18].

Differences in practice prevalence rates were assessed regarding practice characteristics, testing rates and aspects of disease management. Other variables included were: QOF income per practice (expressed as a proportion of total list size)—a marker of the practice’s overall QOF achievement and taken as reflecting organizational ability. Also included were diabetes register size and QOF achievement in all diabetes indicators for each practice. Other factors more specific to diabetic nephropathy were the practices’ albumin-creatinine ratio testing rates in diabetes, and uptake of renin-angiotensin-aldosterone system blockade in microalbuminuria or proteinuria and their associated exception reporting rates. Ethical approval was granted from the Office for Research and Ethics Committee, Northern Ireland (ORECNI) (reference: 07/NIR02/73).

**Statistical analyses**

Practice diabetes prevalence results were normally distributed and expressed as mean and standard deviation. Because distribution was skewed, the geometric mean was used to summarize the prevalence of diabetic nephropathy at practice level.

Data were summarized at practice level prior to further analysis [19]. The prevalence of diabetic nephropathy at practice level was compared between categories of practice level characteristics using the Kruskal–Wallis test. Spearman’s correlation coefficient was calculated to measure the correlation between the prevalence of diabetic nephropathy and other continuous practice level characteristics. Multiple linear regression (log of diabetic nephropathy prevalence as outcome) was used to compare the prevalence of diabetic nephropathy at practice level between categories of practice level characteristics after adjustment for potential confounders (such as list size and income score). The list size proportion above age 65 years was used to adjust for age; likewise the proportion of the practice’s diabetic patients with HbA1c < 7.4% (57 mmol/mol) (i.e. the highest achievement rewarded in QOF) was used to adjust for glycaemia control. The coefficients from this model were presented as the adjusted ratio of geometric means in one category of practice level characteristics compared with another [20]. QOF results for the year 2005–2006 were used for diabetic nephropathy prevalence calculations. SPSS version 15.0 was used for all statistical analyses (SPSS Inc., Chicago, IL, USA).

**Results**

Prevalence calculations for 2004–2008 for diabetes and diabetic nephropathy are demonstrated in Fig. 2 and in the Supporting Information (Appendix S1). In 2004–2005, 5955 diabetes patients were recorded as having diabetic nephropathy (11.5% of prevalent diabetes mellitus patients). This figure increased to 9213 patients in 2007–2008 (15.1% of prevalent diabetes mellitus patients). This represents an absolute 55% increase in diabetes patients noted to have diabetic nephropathy during the period; 35% in the first year of the diabetes QOF.

Prevalence of diabetic nephropathy varied greatly across practices in Northern Ireland. The median practice prevalence of diabetic nephropathy calculated from the QOF diabetic

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Median practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004–05</td>
<td>11.47</td>
<td>13.02</td>
</tr>
<tr>
<td>2005–06</td>
<td>14.58</td>
<td>10.89</td>
</tr>
<tr>
<td>2006–07</td>
<td>15.12</td>
<td>11.63</td>
</tr>
<tr>
<td>2007–08</td>
<td>15.07</td>
<td>11.67</td>
</tr>
</tbody>
</table>

**FIGURE 2** Diabetic nephropathy prevalence calculations (in financial years 2004–2008). Median practice diabetes prevalence (diabetes mellitus/list > 17 years) (corrected denominator for age in diabetes registries) (—); Northern Ireland population diabetic nephropathy prevalence (Northern Ireland diabetic nephropathy/Northern Ireland diabetes mellitus) (—); median general practice diabetic nephropathy prevalence (—).
population in the first year was 13.0% (interquartile range 7.0–22.1). In this year, exception-reporting statistics are not available, so these have not been included in calculations. In the following years, median practice diabetic nephropathy prevalence results were 10.9 (interquartile range 4.1–21.1) and 11.6 (interquartile range 4.9–22.4)%, respectively. Results for 2004–2005 are artificially higher, as a median result is taken from only included practices with numbers of nephropathy patients greater than 5.

Median practice diabetic nephropathy prevalence correlated negatively with diabetes registry size \( (r = -0.11, P = 0.04) \) (Table 1). This relationship between larger diabetes practice size and recorded prevalence became stronger after adjusting for confounding factors, such that for every increase in 100 diabetic patients to the practice register, the mean prevalence of diabetic nephropathy was reduced by 40\% \( (P = 0.003) \).

Overall achievement in the QOF indicators was high, with most practices achieving maximal points in the diabetes domain. Median diabetes achievement was 99.9\%, with the lowest recorded achievement being 65\%. There was no relationship between diabetic nephropathy prevalence and overall diabetes QOF attainment or with total QOF income generated.

Albumin–creatinine ratio testing rates were high at 82\%, with a significant negative correlation between increasing testing rates and diabetic nephropathy prevalence \( (r = -0.18, P = 0.001) \) (Table 2). The prevalence also increased significantly in practices where the testing rate was below 70\% \( (P < 0.01) \), i.e. the maximum payment threshold. The overall trend was a reduction in diabetic nephropathy prevalence of 20\% for every 10\% increase in albumin-creatinine ratio testing rate \( (P \leq 0.01) \). Median uptake of renin-angiotensin-aldosterone system blockade in diabetic nephropathy was 85\%—across all the practices (Table 2).

It was considered that ‘excepting’ patients from nephropathy testing and treatment may explain the differing rates of nephropathy found at a practice level. In 2005–2006, the median Northern Ireland exception rates for albumin-creatinine ratio testing and renin-angiotensin-aldosterone system uptakes in diabetes were 4.3 and 8.3\%, respectively, with the majority of practices not exception reporting in these indicators. There was no correlation between median diabetic nephropathy prevalence and increasing tertiles of albumin-creatinine ratio testing exception rate. However, a non-linear trend was found between prevalence and exception reporting for renin-angiotensin-aldosterone system blockade use (Table 2), where there was minimal exception reporting. In most practices, 253/364, this was < 5\%.

**Discussion**

The major findings of this prevalence study, which exploits the Quality Outcomes Framework statistics in Northern Ireland, where the testing rate was below 70% \( (P < 0.01) \), i.e. the maximum payment threshold. The overall trend was a reduction in diabetic nephropathy prevalence of 20% for every 10% increase in albumin-creatinine ratio testing rate \( (P \leq 0.01) \). Median uptake of renin-angiotensin-aldosterone system blockade in diabetic nephropathy was 85%—across all the practices (Table 2).

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**Table 1** The association between practice level characteristics and diabetic nephropathy prevalence

<table>
<thead>
<tr>
<th>Practice characteristic</th>
<th>Number of practices</th>
<th>Median prevalence DN (IQR)</th>
<th>( P )</th>
<th>Adjusted ratio of mean prevalence (95% CI)</th>
<th>( P \dagger )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 100</td>
<td>112</td>
<td>12.5 (19.5)</td>
<td>0.11*</td>
<td>1.0 (ref. cat.)</td>
<td>0.014</td>
</tr>
<tr>
<td>100–200</td>
<td>162</td>
<td>10.9 (17.5)</td>
<td>0.5 (0.3, 0.8)</td>
<td>0.7 (0.5, 1.0)</td>
<td>0.014</td>
</tr>
<tr>
<td>200–300</td>
<td>67</td>
<td>12.0 (14.8)</td>
<td>0.5 (0.3, 0.8)</td>
<td>1.2 (0.7, 2.1)</td>
<td>0.53</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>23</td>
<td>7.3 (12.6)</td>
<td>0.2 (0.1, 0.6)</td>
<td>0.6 (0.4, 0.9)</td>
<td>0.003</td>
</tr>
<tr>
<td>Trend per 100 people (95% CI)</td>
<td>0.8 (0.7, 1.0)</td>
<td>0.008</td>
<td>0.6 (0.4, 0.9)</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Spearman’s correlation coefficient</td>
<td>−0.11</td>
<td>0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of total points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>achieved in diabetes domain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 99</td>
<td>232</td>
<td>12.0 (17.1)</td>
<td>1.0 (ref. cat.)</td>
<td>1.0 (ref. cat.)</td>
<td>0.398</td>
</tr>
<tr>
<td>98–99</td>
<td>51</td>
<td>10.1 (14.2)</td>
<td>1.2 (0.7, 2.1)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>97–98</td>
<td>24</td>
<td>11.2 (15.9)</td>
<td>0.9 (0.6, 1.5)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>&lt; 97</td>
<td>57</td>
<td>9.1 (19.4)</td>
<td>1.2 (0.8, 1.7)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>Trend per 1% reduction (95% CI)</td>
<td>1.0 (0.9, 1.1)</td>
<td>0.955</td>
<td>1.1 (0.9, 1.2)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>Spearman’s correlation coefficient</td>
<td>0.069</td>
<td>0.186</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total QOF pay per list</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>91</td>
<td>13.1 (16.6)</td>
<td>1.0 (ref. cat.)</td>
<td>1.0 (ref. cat.)</td>
<td>0.398</td>
</tr>
<tr>
<td>2</td>
<td>91</td>
<td>10.6 (17.5)</td>
<td>0.9 (0.6, 1.2)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>91</td>
<td>11.2 (17.0)</td>
<td>1.0 (0.7, 1.4)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>91</td>
<td>10.1 (15.6)</td>
<td>0.8 (0.6, 1.2)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>Trend per increasing quartile (95% CI)</td>
<td>1.0 (0.9, 1.0)</td>
<td>0.325</td>
<td>1.0 (0.8, 1.1)</td>
<td>0.398</td>
<td></td>
</tr>
<tr>
<td>Spearman’s correlation coefficient</td>
<td>−0.04</td>
<td>0.437</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Kruskal–Wallis test.
†Ratio of geometric mean. Increase in geometric mean prevalence per unit increase in variable. Adjusted for list size, income score, proportion > 65 years and proportion with HbA\(_1c\) < 7.4% (57 mmol/mol).
‡Value from linear regression.

DN, diabetic nephropathy; IQR, interquartile range; QOF, Quality and Outcomes Framework; ref. cat., reference category.
were, firstly, that the diabetes prevalence rates appear comparable with the rest of the United Kingdom at 3.1% in 2005–2006. When corrected for the ages excluded from the diabetes registers, the figure rose to 4.0%. In comparison with the slowly increasing prevalence of diabetes in adults, the documented prevalence of nephropathy grew significantly in absolute numbers, with a 55% increase from 2004 through to 2008. The prevalence (per diabetes register) increased from 11.5% in 2004–2005 to 15.1% in 2006–2007, reflecting the growth in the denominator of registered diabetes patients. In contrast to other studies, the QOF-calculated diabetic nephropathy prevalence in 2007–2008 is considerably lower than expected (15%). It is likely that this still reflects incomplete testing of the at-risk population despite the median 82% albumin-creatinine ratio testing rate. Compared with other parts of the United Kingdom, primary care in Northern Ireland has the highest achievement of QOF screening and treatment targets for cardiovascular disease and diabetes care [21]. The limitations of the QOF must also be considered. Firstly, the natural history of nephropathy is such that onset usually occurs after 5–10 years of diabetes onset. If, after the QOF, general practitioners were screening for and diagnosing more diabetes (earlier than they did hitherto), the complication rate ascertained in the first years of the scheme may be lower. In addition, using the presence of microalbuminuria or proteinuria as a method of identifying patients with diabetic nephropathy will miss those diabetic patients with ischaemic nephropathy in whom there is often a normal albumin-creatinine ratio but reduced renal function.

Secondly, United Kingdom guidelines for establishing diagnosis based on albumin-creatinine ratio are in place and recommend repeat albumin-creatinine ratio sampling for results in the microalbuminuria range [9]. Confirmation of diagnosis could not be verified in this study, which relies on accurate general practitioner reporting of abnormal results. There may be patients who have one abnormal test and are not coded as nephropathic until confirmation. Future research should try and establish the positive predictive values for albumin-creatinine ratios across the range of results, as repeated tests may delay diagnosis and treatment for some patients.
which are incident cases. It would be more informative if QOF registers facilitated an analysis of numbers being annually added and removed. Practice management may also change over relatively short periods as a result of retirements and new appointments, with patients perhaps opting to attend certain practitioners with special interests in diabetes.

There is maximum variation in the prevalence of diabetic nephropathy at general practice level (see also Supporting Information, Appendix S1). After adjusting for factors specific to the practice, such as age distribution, deprivation, practice size and diabetes control, the features that most explain these variations are the number of diabetic patients attending the practice, practice achievement in screening for albuminuria and subsequent management. An important finding from this study is that, in practices with more diabetic patients, the prevalence of diabetic nephropathy tends to be lower. One hypothesis is that, amongst practices with relatively fewer cases of diabetes (smaller case registers), those with more severe disease (i.e. with diabetic nephropathy) are over-represented. Practices with larger diabetes registers may have more of their patients attending hospital diabetes clinics and therefore whose diabetic nephropathy status is inadvertently missed off or poorly recorded in the general practice registers. Alternatively, those practices may screen for diabetes more and therefore pick up early cases with a shorter duration.

Does a greater volume of diabetic patients reduce the chances of picking up complications or are the practices with larger registers better at screening and treating diabetes and thus preventing complications? It may be simply that financial incentives have resulted in more diabetes patients being screened and less complex cases detected. Previous studies on cardiovascular disease found little relationship between caseload and quality of care [22]. Another study assessing the prevalence of diabetes mellitus found, as in this study, that smaller practices have a higher prevalence of nephropathy [23].

Eighty per cent of practices tested > 70% of their diabetic patients for albumin-creatinine ratio, similar to other studies of QOF achievement. One English study documented that the albumin-creatinine ratio testing rate increased to 77% from 7% in 2004 pre-QOF [24]. Another study conducted in Northern Ireland before the QOF found albumin-creatinine ratio testing rates to be 41% [25].

Practices with greater documented use of renin-angiotensin system blockade in diabetic nephropathy had lower recorded prevalence rates, but this relationship was not linear. Mean adjusted prevalence rates were lowest in those practices recording > 90% achievement in blockade in indicated patients, after initially increasing with more usage of these drugs. This may reflect selective use in what practitioners deem to be a higher risk of diabetic nephropathy, or possibly practices able to achieve more than 90% uptake of renin-angiotensin-aldosterone system blockade may have had good screening and treatment measures in place before the introduction of the QOF.

Exception reporting for albumin-creatinine ratio testing did not correlate with recorded diabetic nephropathy prevalence; however, exceptions for the use of renin-angiotensin-aldosterone system blockade in diabetic nephropathy patients correlated positively ($r = 0.29$, $P < 0.01$). Previously, reports correlating high levels of exception reporting and performance in the QOF raised fears about ‘gaming’—to increase practice achievement and income [26]—but a further larger study found little evidence of this [27]. Here, practices with the highest exceptions ($> 4.3\%$) had twice the prevalence rates of those practices with no exception reporting. Perhaps these practices have a greater number of patients with co-morbidities and are more susceptible to exception reporting.

Better-organized practices are more likely to achieve glycemic control [27]. In this study, the weighted mean total income from the QOF was taken as a measure with which to compare how practices performed in all aspects of the QOF, both in clinical and organizational domains. Here, there was neither a significant correlation between increasing QOF income nor between overall diabetes achievement and recorded diabetic nephropathy prevalence. It is suggested that a practices’ overall organizational response to the QOF had no effect on its ability to diagnose and register nephropathy and that the general quality of diabetes care had no bearing on current nephropathy prevalence. General diabetes care has been shown to have been improving prior to the onset of the QOF, with the financial incentives having little impact in the longer term [28]. A more prolonged analysis taking into account the length of time usually required to develop diabetic nephropathy is needed to further explore this point.

In conclusion, registered diabetic nephropathy prevalence as calculated from the QOF initially increased to a stable level, but remains less than in formal population-based studies. Very large variation in diabetic nephropathy prevalence remains throughout this period and it is associated with diabetes registry size, screening and treatment practices and suggests that understanding this variation may help practices target diabetic nephropathy patients.

Competing interests

GMM received an educational grant from Takeda and Novo Nordisk for travel expenses to present an abstract at the American Society of Nephrology. GMM has received an honorarium from Novartis; SJH has received honoraria from Sanofi Aventis and Takeda; DGF has received honoraria from Roche, Amgen, BMS, Sanofi-Aventis, MSD, Takeda, Novo Nordisk, Genzyme and Napp and educational grants from Roche, Amgen, Takeda, Novo Nordisk and Genzyme. The other authors have no competing interests to declare.

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assistance of the Central Services Agency, Belfast for providing general practice ward counts and age bands.

References


Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. The Quality and Outcomes Framework (QOF): a pay-for-performance system for family practitioners.

Appendix S2. Prevalence results.

Table S1. Relevant clinical indicator and points for diabetes mellitus domain 2005–2006.

Table S2. Exception reporting criteria.

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