ORIGINAL ARTICLE

The effect of screening on the prevalence of diagnosed type 2 diabetes in primary care

MARK SPIG1, ANNELIES RIKKERS1, MIRTE DOORNBIOS1, EVELYN WOUTERS1, ISI SPITZ2, LUDOVIC VAN AMELSVOORT2 & PAUL ZWIETERING1

1Maastricht University, Department of General Practice, School for Public Health and Primary Care (CAPHRI), and 2Maastricht University, Department of epidemiology, School for Public Health and Primary Care (CAPHRI)

Abstract

Objective. To investigate to what extent differences in diagnosed diabetes prevalence can be attributed to differences in the general practitioner’s (GP) screening activity. Design. An analysis of electronic patient files in combination with a survey among GPs. Setting. Ten primary healthcare centres with 44 GPs in the Netherlands. Patients. General population (n = 58,919) and type 2 diabetic patients (n = 2582). Main outcome measures. Each GP filled in a questionnaire with questions concerning screening methods for diabetes. The presence of diabetes and date of diagnosis were determined. The potential confounding variables age, sex, and postal code (which we used to determine socioeconomic status) were retrieved from patient records. Results. The yearly point prevalence of diabetes increased significantly from 2.92% in 2000–2001 to 4.25% in 2005–2006 (p = 0.002). The incidence increased from 3.29/1000 person-years to 5.13/1000 person-years (p = 0.019). High screening activity of the general practitioner resulted in statistically significantly higher odds (1.35; p = 0.015) of being diagnosed as a patient with diabetes. The effect was independent of the influence of age, gender, and socioeconomic status. Conclusion. Screening activity of the GP has a statistically significant and relevant influence on the prevalence of diagnosed diabetes. General practitioners should evaluate their screening activity to optimize the identification of diabetic patients.

Key Words: Diabetes mellitus type 2, family practice, incidence, physician’s practice patterns, prevalence, socioeconomic factors

Diabetes mellitus type 2 is a common disease with serious consequences. In Western countries as well as in developing countries the prevalence of diabetes is increasing [1–6]. Approximately 24–30% of diabetes remains undiagnosed [1,7,8]. Finding diabetic patients in an early stage of their disease is assumed to reduce the occurrence of morbidity and mortality [9,10]. It is known that considerable differences in diabetes prevalence exist between primary care practices [11,12]. Different factors, such as differences in age and socioeconomic status, could explain part of this variation. Active screening should logically increase the incidence and prevalence of diabetes by changing the ratio of diagnosed versus undiagnosed diabetes. This raises the question of whether differences in diabetes prevalence can be attributed to screening activity. To our knowledge only one article by Whitford et al. has been published regarding the influence of screening activity on the prevalence of diabetes [13].

Diabetes prevalence is rising dramatically, but it is unknown to what extent differences in diabetes prevalence can be attributed to screening activity.

- High screening activity of the general practitioner resulted in a 35% higher chance of being diagnosed as a patient with diabetes.

They selected a random sample of 20% of all patients with diabetes from 42 general practices in England and correlated patient and practice characteristics with diabetes prevalence. The main finding was that socioeconomic status rather than screening activity...
accounted for the variation in prevalence between practices.

It is important to know whether and to what extent the general practitioner (GP) can contribute to effective screening. We studied the prevalence and incidence of diabetes type 2 in the regular primary healthcare setting between 2000 and 2005, and determined the influence of the GP's screening activity.

**Material and methods**

**Design**

We performed a study among 44 GPs who were assessed on the methods they used to screen for type 2 diabetes mellitus. The screening activity was subsequently related to diabetes prevalence in their practices. We adjusted for differences between practices in age, gender, and socioeconomic status.

**Setting**

We performed our study among 44 GPs. Most of these GPs work together in primary healthcare centres (10 sites). The healthcare centres are located in the Netherlands, and are linked to the Maastricht University Registration Network (RNH) [14]. Due to the connection to the RNH, the GPs are well trained and conscientious at keeping electronic medical files for their patients. Information on this study was given to the participating GPs in August 2006.

**Assessment of screening activity**

We constructed a checklist (see Table II) on which the GP could indicate whether they screened patients with risk factors when they came to the surgery for another reason (targeted screening), and/or whether they specifically invited certain risk groups (e.g. hypertension, manifest cardiovascular disease, disturbed lipid spectrum, or overweight) to invite them for blood glucose testing (screening programme). This checklist was administered to 38 GPs. Six GPs were employed after 2005 and were therefore not invited to fill in the checklist. We measured the compliance with 12 possible targeted screening measures and four possible screening programmes. Each targeted screening measure was scored with one point; specific screening programmes were considered more comprehensive and were thus scored with two points, resulting in a maximum score of 20 points.

**Patient population**

Every patient registered in the 10 healthcare centres was included in the study, resulting in a total study population of 61,501 patients. Type 2 diabetes status was determined by registration code, the international classification of primary care (ICPC) code of diabetes mellitus, and prescriptions of anti-diabetic drugs by the anatomic, therapeutic, chemical classification (ATC) code.

The electronic records of all diabetic patients were retrospectively examined to obtain the date of diagnosis of diabetes. For the date of the diagnosis we used the date the diabetes was first documented by the GP. When correct documentation was absent, we determined the date of diagnosis on the basis of deviant blood glucose levels in the laboratory results, or the first day anti-diabetic medication was prescribed. We used the running database for patients who were registered in the practice and the archive for the patients who had died or moved during the study period. From every patient in the database (diabetic and non-diabetic) we looked up the date of birth, gender, and postal code.

**Deprivation score**

Data on socioeconomic status were retrieved from the Social and Cultural Planning Office of the Netherlands [15]. They provided us with a deprivation score per postal code. The determination of the deprivation score is based on continuous telephone surveys in every postal code area in the Netherlands. Every four years this information is updated. This way we could determine the socioeconomic status for all the patients registered in the general practices. The deprivation score is based on unemployment, level of education, and income. A higher deprivation score corresponds to a lower socioeconomic status.

**Statistical analyses**

The collected data of all patients were analysed with SPSS 13.0 and SAS 9.1 for Windows. We calculated the prevalence of diabetes for 2000 and 2005 and the yearly incidence between these years. Linear regression was used for the significance of the trend in incidence.

The differences in mean age and deprivation score between diabetic and non-diabetic patients were calculated with t-tests. The differences between these groups in gender and age (over 65 years or aged 45 to 64 years) were calculated using a chi-square test.

The influence of screening activity was calculated using GEE modelling, a method that accounts for the multilevel data structure, assuming an unstructured correlation matrix. GEE modelling was done using the PROC GENMOD module of SAS 9.1. Liang and Zeger (1986) introduced GEE as a method
of dealing with correlated data when the data can be modelled as a generalized linear model [16]. This method can be applied to correlated binary data as in this case. That is, observations from all patients from one practice are somewhat correlated, thereby violating the assumption of independence needed for standard logistic regression. Since patients within a healthcare centre cannot be linked to individual GPs, an average screening score for each centre was calculated and included in the model. The effect of screening activity was adjusted for differences in socioeconomic status, age, and sex of the patients. A p-value < 0.05 was considered statistically significant.

Results

Prevalence and incidence

On 31 December 2005 the 10 healthcare centres had a total population of 60,704 patients. The mean age of the total patient population was 41.3 years (range 38.8 to 44.7), 48.9% of the patients were male. A total of 2582 patients were diagnosed with diabetes type 2, resulting in a point prevalence of 4.25%. The prevalence between practices varied from 2.97% to 6.39% (SD 1.04). In 2000 the prevalence was 2.92% (range between practices: 2.04% to 4.03%; SD 0.65). The increase in prevalence between 2000 and 2005 was statistically significant (p = 0.002).

In 2000 the mean incidence was 3.29/1000 person-years and increased to 5.13/1000 person-years in 2005 (Figure 1). The yearly increase in incidence was statistically significant (B = 0.507, CI = 0.087 to 0.926). The practice with the highest incidence in 2003 took part in a screening programme that had started that year.

Patient characteristics

The age, sex, and deprivation scores of diabetic patients and non-diabetic patients are given in Table I. The diabetic patients were older and had a statistically significantly higher deprivation score (p ≤ 0.001), which represents a lower socioeconomic status.

Screening activity

Table II shows the different screening activities and the distribution between GPs. Besides screening in patients with symptoms possibly related to diabetes, it showed that almost all GPs screened for diabetes on request and when a patient with hypertension and cardiovascular disease visits the practice. Other targeted screening activities were less common. Most of the GPs did not engage in specific screening programmes. The GPs scored on average 9.9 (range 6 to 18) points on our screening activity questionnaire.

Figure 1. Yearly incidence of diabetes per GP, with trend line.
Effect of screening on prevalence of type 2 diabetes

Table I. Characteristics of all registered patients of the 10 primary healthcare centres in 2005.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Non-diabetic patients</th>
<th>Diabetic patients</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>39.8 (SD 22.1)</td>
<td>66.9 (SD 12.3)</td>
<td>≤0.001</td>
</tr>
<tr>
<td>Age ≥65 years (%)</td>
<td>14.6</td>
<td>59.4</td>
<td>≤0.001</td>
</tr>
<tr>
<td>45–64 years (%)</td>
<td>29.2</td>
<td>35.7</td>
<td>≤0.001</td>
</tr>
<tr>
<td>Male (%)</td>
<td>48.7</td>
<td>49.7</td>
<td>0.296</td>
</tr>
<tr>
<td>Mean deprivation score¹</td>
<td>0.41 (SD 0.83)</td>
<td>0.55 (SD 0.80)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: ¹A high score represents a lower socioeconomic status.

Discussion

Our study demonstrates that an increase in the GP’s screening activity by five points on our screening score is associated with a 35% higher prevalence of diagnosed type 2 diabetes patients. Not much is needed to increase the screening activity score by five points. Our results indicate that adopting for example one screening programme and three targeted screening activities will be sufficient to increase the prevalence by 35%. This effect is large enough for the lowest observed prevalence rate to come close to the average.

The observed 2.92% prevalence of diabetes in 2000 in our population was comparable with the outcome of other studies [5,17]. Wild et al. [18] predicted that the prevalence of diabetes will be 4.4% in 2030. Our 4.25% prevalence in 2005 already approached this predicted prevalence, but is similar to the incidence trend reported by Ryan et al. [19], suggesting an even worse picture than anticipated. However, as we have shown, the rise in screening activity may have contributed to the observed increase in prevalence. The influence of screening activity will probably decrease in the coming years if more and more GPs adopt more screening activities. The increase in incidence will then depend on changes in patient characteristics such as obesity or physical inactivity.

The significant correlation between socioeconomic status and the prevalence of diabetes corresponds with earlier studies [13,20–22]. Our observed association between diabetes diagnosis and screening activity is in line with a recently published paper by Janssen et al. [12]. They showed that having a practice assistant involved with diabetes results in a higher prevalence of diabetes. Probably the higher prevalence due to the presence of a practice assistant is the result of increased screening activities such as we describe. Our results are in contrast, however, with the results of Whitford et al. [13]. In our opinion the main difference between the two studies can be attributed to differences in statistical power and measurement accuracy. Whitford et al. measured and analysed the variables at practice level, thus including 42 cases in the analysis. By adjusting for independent parameters,

Influence of screening activity

The multilevel GEE regression analysis showed that screening activity is statistically significantly related to the presence of a diabetes diagnosis. The odds ratio for screening activity indicates that patients have a 35% higher chance of being registered as having diabetes type 2 for every five-point increase in screening score of his or her GP.

The odds ratio was adjusted for differences in age, gender, and socioeconomic status. These confounding variables were also statistically significantly related to diabetes diagnosis, meaning that the elderly, males, and people with low socioeconomic status had a higher chance of being diagnosed as a diabetic patient (Table III).

Table II. How often are different screening activities used by the GPs?

<table>
<thead>
<tr>
<th>Which patient groups do you screen?</th>
<th>(% of GPs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted screening in patients with:</td>
<td></td>
</tr>
<tr>
<td>Diabetic complaints</td>
<td>100</td>
</tr>
<tr>
<td>Requested by patient, no complaints</td>
<td>95</td>
</tr>
<tr>
<td>Hypertension</td>
<td>97</td>
</tr>
<tr>
<td>Manifest cardiovascular disease</td>
<td>92</td>
</tr>
<tr>
<td>Disturbed lipid spectrum</td>
<td>87</td>
</tr>
<tr>
<td>Overweight (BMI &gt; 27 kg/m²)</td>
<td>39</td>
</tr>
<tr>
<td>Familiar history of cardiovascular events</td>
<td>61</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>24</td>
</tr>
<tr>
<td>Patients &gt; 50 years</td>
<td>29</td>
</tr>
<tr>
<td>With every laboratory investigation in patients &gt; 45 years</td>
<td>55</td>
</tr>
<tr>
<td>Women with gestational diabetes</td>
<td>63</td>
</tr>
<tr>
<td>Other groups¹</td>
<td>32</td>
</tr>
<tr>
<td>Screening programme in patient groups²</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>32</td>
</tr>
<tr>
<td>Manifest cardiovascular disease</td>
<td>29</td>
</tr>
<tr>
<td>Disturbed lipid spectrum</td>
<td>21</td>
</tr>
<tr>
<td>Overweight (BMI &gt; 27 kg/m²)</td>
<td>3</td>
</tr>
</tbody>
</table>

Notes: ¹Including: indefinite complaints, mycoses, relapsing urinary tract infection, use of prednisone, medical examination for example for a driving licence, all new patients in the practice. ²These programmes involve inviting certain risk groups for blood glucose testing.
found large and statistically significant differences in diabetes prevalence in relation to screening activity. With a less homogeneous population and thus larger differences between centres, the chance of finding statistically significant differences would probably increase. Therefore, we expect that if there is bias in our estimation this would probably mean that we underestimated the effect of screening activity.

Another potential source of bias is incomplete control over confounders. In our study we controlled for possible differences between practices in age, gender, and socioeconomic status of their patients. In our opinion these are the most important potential confounders for the relationship between screening activity and depression prevalence. However, as in every observational study, it is never certain whether there could be additional non-measured confounding.

Acknowledgements
The authors would like to thank the general practices for their help in retrieving the data for this study. Appreciation is expressed especially to Jos Boesten, MD, for solving the authors’ problems concerning electronic patient files.

Ethical approval
All patients gave permission to use their medical data for scientific research when they joined the RNH practices. No further ethical approval was required for this research.

Conflict of interests and source of funding:
There was no external source of funding. The authors have no conflicts of interests to declare related to this paper.

References

Table III. Association between screening activity and type 2 diabetes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio (OR)</th>
<th>95% confidence interval (CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening score</td>
<td>1.35</td>
<td>1.06–1.70</td>
<td>0.015</td>
</tr>
<tr>
<td>Age</td>
<td>1.64</td>
<td>1.55–1.73</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>1.20</td>
<td>1.11–1.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Deprivation score</td>
<td>1.15</td>
<td>1.09–1.22</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Notes: ^1OR per five-point increase in the score; ^2OR per 10 years increase in age; ^3OR of males when compared with females; ^4OR per one-point increase in the score.
Effect of screening on prevalence of type 2 diabetes

237


