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ORIGINAL ARTICLE

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

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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]. 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

> Diabetes prevalence is rising dramatically, but it is unknown to what extent differences in diabetes prevalence can be attributed to screening activity.
>
> - The yearly point prevalence of diabetes increased significantly from 2.92% in 2000–2001 to 4.25% in 2005–2006.
> - High screening activity of the general practitioner resulted in a 35% higher chance of being diagnosed as a patient with diabetes.

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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 correspondends 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 ($p \leq 0.001$), 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.

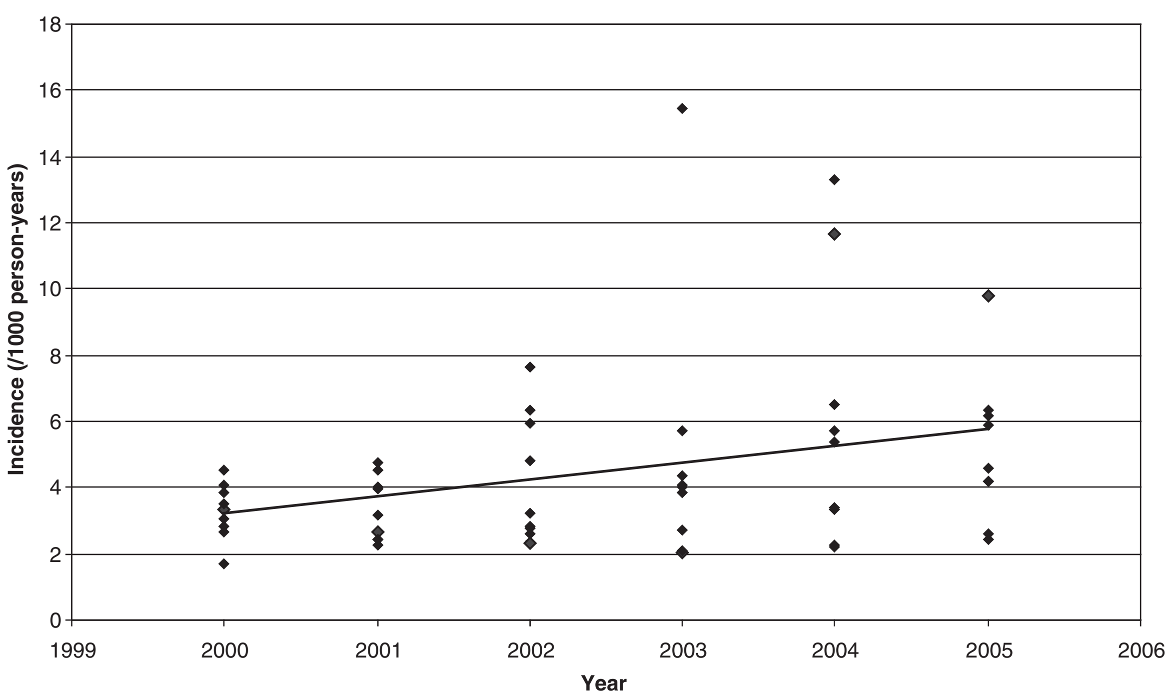

Figure 1. Yearly incidence of diabetes per GP, with trend line.

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

Characteristic	Non-diabetic patients n = 58,919	Diabetic patients n = 2,582	p-value
Mean age (years)	39.8 (SD 22.1)	66.9 (SD 12.3)	≤0.001
Age			
≥65 years (%)	14.6	59.4	≤0.001
45–64 years (%)	29.2	35.7	≤0.001
Male (%)	48.7	49.7	0.296
Mean deprivation score[1]	0.41 (SD 0.83)	0.55 (SD 0.80)	<0.001

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

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?

Which patient groups do you screen?	(% of GPs)
Targeted screening in patients with:	Yes
Diabetic complaints	100
Requested by patient, no complaints	95
Hypertension	97
Manifest cardiovascular disease	92
Disturbed lipid spectrum	87
Overweight (BMI > 27 kg/m^2)	39
Familiar history of cardiovascular events	61
Ethnicity	24
Patients > 50 years	29
With every laboratory investigation in patients > 45 years	55
Women with gestational diabetes	63
Other groups[1]	32
Screening programme in patient groups[2]	
Hypertension	32
Manifest cardiovascular disease	29
Disturbed lipid spectrum	21
Overweight (BMI > 27 kg/m^2)	3

Notes: [1]Including: indefinite complaints, mycoses, relapsing urinary tract infection, use of prednisone, medical examination for example for a driving licence, all new patients in the practice. [2]These programmes involve inviting certain risk groups for blood glucose testing.

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 than 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,

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

Variable	Odds ratio (OR)	95% confidence interval (CI)	p-value
Screening score[1]	1.35	1.06–1.70	0.015
Age[2]	1.64	1.55–1.73	<0.001
Sex (male)[3]	1.20	1.11–1.31	<0.001
Deprivation score[4]	1.15	1.09–1.22	<0.001

Notes: [1]OR per five-point increase in the score; [2]OR per 10 years increase in age; [3]OR of males when compared with females; [4]OR per one-point increase in the score.

measured on a patient level as well as GP level, where applicable, the multilevel model generates a more precise estimate of the risk of a patient for having diabetes, thereby diminishing statistical variation and thus increasing the power of our study to estimate the influence of the independent parameter on a GP level. In addition, Whitford et al. did not compose a screening activity score as we did in our study. This could also explain the difference between our study and a study by Jansson et al. that also did not find large differences in diabetes incidence from 1972 to 2001, despite changes in diagnostic criteria during the study period [23]. By calculating a total screening score we were able to measure screening activity accurately, which could have led to more contrast between practices and thus statistical power. It cannot be ruled out that differences between the studies are due to the differences in setting and time. For example, it is possible that when we performed our study differences between practices as regards screening activity were larger than in 2000.

Since we calculated a total screening score and determined the average score per healthcare centre, we could only determine general trends in the relationship between screening and prevalence. However, it is possible that some screening activities have a larger effect on prevalence than others. It is for example possible that adopting screening programmes for patients with obesity and/or hypertension has a bigger influence on prevalence than others. Obesity for example is the major risk factor for diabetes [24], but the majority of GPs in our study did not screen obese patients. To identify which screening programme is most effective, further research is needed with more practices and more variation in screening programmes.

This study was done in all 10 healthcare centres that have a close collaboration with our department and are used to register patient information. The databases of these centres are frequently used for primary care research. This could have implications for the generalization of our results. It is possible that the centres included in our study are rather homogeneous when it comes to quality of care, or in adopting new strategies etc. Despite this homogeneity we find 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.

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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.

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References

[1] Gregg EW, Cadwell BL, Cheng YJ, Cowie CC, Williams DE, Geiss L, et al. Trends in the prevalence and ratio of diagnosed to undiagnosed diabetes according to obesity levels in the US. Diabetes Care 2004;27:2806–12.

[2] Stock SA, Redaelli M, Wendland G, Civello D, Lauterbach KW. Diabetes –prevalence and cost of illness in Germany: A study evaluating data from the statutory health insurance in Germany. Diabet Med 2006;23:299–305.

[3] Mohan V, Deepa M, Deepa R, Shanthirani CS, Farooq S, Ganesan A, et al. Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban South India – the ChennaI Urban Rural Epidemiology Study (CURES–17). Diabetologia 2006;49:1175–8.

[4] Green A, Stovring H, Andersen M, Beck Nielsen H. The epidemic of type 2 diabetes is a statistical artefact. Diabetologia 2005;48:1456–8.

[5] Whitford DL, Roberts SH. Changes in prevalence and site of care of diabetes in a health district 1991–2001. Diabet Med 2004;21:640–3.

[6] Tseng CH, Tseng CP, Chong CK, Huang TP, Song YM, Chou CW, et al. Increasing incidence of diagnosed type 2 diabetes in Taiwan: Analysis of data from a national cohort. Diabetologia 2006;49:1755–60.

[7] Panagiotakos DB, Pitsavos C, Chrysohoou C, Stefanadis C. The epidemiology of Type 2 diabetes mellitus in Greek adults: The ATTICA study. Diabet Med 2005;22:1581–8.

[8] Simmons D, McKenzie A, Eaton S, Shaw J, Zimmet P. Prevalence of diabetes in rural Victoria. Diabetes Res Clin Pract 2005;70:287–90.

[9] Kristensen JK, Stoevring H. A follow-up study of the occurrence and consequences of HbA1c measurements in an unselected cohort of non-pharmacologically treated patients with Type 2 diabetes. Scand J Prim Health Care 2008;26:57–62.

[10] Rasmussen SS, Glumer C, Sandbaek A, Lauritzen T, Borch-Johnsen K. General effect on high-risk persons when general practitioners are trained in intensive treatment of type 2 diabetes. Scand J Prim Health Care 2008;26:166–73.

[11] Meadows P. Variation of diabetes mellitus prevalence in general practice and its relation to deprivation. Diabet Med 1995;12:696–700.

[12] Janssen PG, Gorter KJ, Stolk RP, Rutten GE. Do characteristics of practices and general practitioners influence the yield of diabetes screening in primary care? The ADDITION Netherlands study. 2008;26:160–5.

[13] Whitford DL, Griffin SJ, Prevost AT. Influences on the variation in prevalence of type 2 diabetes between general practices: Practice, patient or socioeconomic factors? Br J Gen Pract 2002;52:9–14.

[14] Van den Akker M, Buntinx F, Metsemakers JF, Roos S, Knottnerus JA. Multimorbidity in general practice: Prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. J Clin Epidemiol 1998;51:367–75.

[15] Sociaal en Cultureel Planbureau. Rangorde naar sociale status van postcodegebieden in Nederland; 2006.

[16] Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. Biometrika 1986;73:13–22.

[17] Meisinger C, Döring A, Heier M, Thorand B, Löwel H. Type 2 diabetes mellitus in Augsburg – an epidemiological overview. Gesundheitswesen 2005;67:S103–9.

[18] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:1047–53.

[19] Ryan R, Newnham A, Khunti K, Majeed A. New cases of diabetes mellitus in England and Wales, 1994–1998: Database study. Public Health 2005;119:892–9.

[20] Connolly V, Unwin N, Sherriff P, Bilous R, Kelly W. Diabetes prevalence and socioeconomic status: A population based study showing increased prevalence of type 2 diabetes mellitus in deprived areas. J Epidemiol Community Health 2000;54:173–7.

[21] Evans JM, Newton RW, Ruta DA, MacDonald TM, Morris AD. Socio-economic status, obesity and prevalence of Type 1 and Type 2 diabetes mellitus. Diabet Med 2000; 17:478–80.

[22] Goyder E, Hammersley V. Explaining variations in reported diabetes prevalence in general practice: How much variation is explained by differences between practice populations? Br J Gen Pract 2003;53:642–4.

[23] Jansson SP, Andersson DK, Svardsudd K. Prevalence and incidence rate of diabetes mellitus in a Swedish community during 30 years of follow-up. Diabetologia 2007;50:703–10.

[24] Perry IJ, Wannamethee SG, Walker MK, Thomson AG, Whincup PH, Shaper AG. Prospective study of risk factors for development of non-insulin dependent diabetes in middle aged British men. BMJ 1995;310:560–4.