Antihyperglycaemic treatment of type 2 diabetes: results from a national diabetes register

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Aim. – To describe clinical characteristics and antihyperglycaemic treatment patterns in patients with varying duration of diabetes.

Methods. – We performed a cross-sectional survey of 61 890 type 2 diabetic (DM2) patients from the Swedish National Diabetes Register (NDR) in 2004. We also analysed the effect of types of treatment and risk factors on glycaemic control in a longitudinal cohort study from 1996 to 2004. HbA1c, risk factors and treatments were determined locally in primary care as well as hospital outpatient clinics.

Results. – Insulin was frequently used in DM2 patients with long duration of diabetes, although the mean HbA1c increased and only a few in this group reached HbA1c < 7.0%. Patients showing long-term improvement in HbA1c (> 1%) from 1996 to 2004 were more often treated with insulin than with oral hypoglycaemic agents (OHA). During this period, the HbA1c levels leading to additional treatment decreased. A low BMI, decreasing BMI and not smoking were predictors of good long-term metabolic control. Hypertension and hyperlipidaemia were frequent in both newly diagnosed DM2 patients and in patients with a long duration of diabetes.

Conclusions. – Insulin treatment was frequently used, particularly in patients with a long duration of DM2. The glycaemic control, which usually deteriorates over time, did not reach the recommended goal, despite the fact that complementary treatment was added at lower HbA1c levels in 2003 than in 1996. High frequencies of hypertension, hyperlipidaemia and high 10-year risks of coronary heart disease necessitate intensified risk factor control in the future.

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Résumé

Traitement hypoglycémiant du diabète de type 2 : données d’un registre national du diabète

But. – Décrire les caractéristiques cliniques et le traitement hypoglycémiant de patients avec une durée variable de diabète.


Résultats. – L’insuline a été fréquemment utilisée chez les patients atteints de DM2 de longue durée d’évolution, bien que l’HbA1c moyenne ait augmenté. Un petit nombre seulement de patients de ce groupe a atteint une HbA1c < 7,0 %. Les patients chez qui a été observée une amélioration à long terme de l’HbA1c (> 1%) de 1996 à 2004 étaient plus souvent traités par insuline que par des hypoglycémiants oraux (OHA). Durant cette période, les niveaux d’HbA1c conduisant à instituer un traitement additionnel ont été abaissés. Un indice de masse corporelle

Abbreviations: BMI, body mass index; CHD, coronary heart disease; DCCT, diabetes control and complications trial; HbA1c, glycated haemoglobin; HDL, high density lipoprotein; LDL, low density lipoprotein; OHA, oral hypoglycaemic agent; UKPDS, United Kingdom Prospective Diabetes Study.

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been indisputably to also reduce cardiovascular risk[3,4]. It is crucial that these agents are used optimally in order to achieve the recently revised glycaemic target levels of HbA1c < 6.1% in Europe and < 7.0% in the USA[5,6]. However, the gap between clinical results and such guidelines is still alarmingly large[7,8], although results from the Swedish National Diabetes Register (NDR) have shown that there has been some improvement in metabolic and risk factor control between 1996 and 2003[7,9,10].

We undertook this study in order to analyse the clinical characteristics and pharmacological treatment patterns in DM2 patients in Sweden using data from the NDR. The primary aim was to analyse the clinical characteristics and pharmacological treatment in patients with increasing duration of diabetes in the cross-sectional survey in 2004. We also used longitudinal studies of patients followed individually from 1996 to 2004 in order to study the association between long-term decrease in HbA1c and type of hypoglycaemic treatment, to study HbA1c levels preceding changes in hypoglycaemic treatment, and to analyse various risk factors as predictors of long-term control of HbA1c.

2. Patients and methods

The NDR was launched in 1996 as part of the Swedish implementation of the principles of the St. Vincent declaration on quality in diabetes care[11]. The aims of the NDR are to monitor diabetes care and to encourage the registration of all diabetic patients at least once a year, enabling health centres to use national results as benchmarking tools in quality assurance in diabetes care. Reporting to the NDR is not obligatory, but all hospital diabetes outpatient clinics as well as primary health care centres are encouraged to participate. All patients are informed about the register before agreeing to be included. The registration of patients is generally carried out by trained nurses or physicians using a printed form, or by transfer of data from clinical records databases. All information is subsequently stored in a central database. Since 2002 it has been possible to register patients via the Internet (www.ndr.nu), a service developed by C&S Healthcare AB (Mölndal, Sweden).

This study, approved by the Regional Ethics Committee at Göteborg University, comprises results obtained in 2004, with approximately 90% of all diabetes clinics and 60% of all primary care centres in Sweden participating. The mean number of diabetic patients in 2004 was 162 per participating unit. All type 2 diabetic patients with data available for diabetes duration and various clinical characteristics were analysed in the cross-sectional study in 2004 (N = 61,890), also including a subgroup of 3471 patients with newly diagnosed diabetes. A longitudinal study of 3522 type 2 diabetic patients was designed to analyse the development of HbA1c from 1996 to 2004 with regard to type of hypoglycaemic treatment. All patients with relevant data available in 1996 and 2004 were included, constituting 20% of all patients in the NDR in 1996. These patients were treated in primary health care (66%) as well as hospital outpatient clinics (34%). Finally, a longitudinal study of 4742 type 2 patients, selected with the same inclusion criteria, examined predictors of glycaemic control in groups with low, increasing or decreasing HbA1c values from 1996 to 2004.

All patients were older than 18 years at the time of the study. The definition of type 2 diabetes applied was treatment with diet only or OHA only, or with either insulin only or OHA in combination with insulin, in patients 40 years of age or older when diabetes was diagnosed. The clinical characteristics of the patients including age at onset of diabetes, duration of diabetes, type of treatment, weight, height and HbA1c were reported. Variables such as smoking, and use of antihypertensive and lipid-lowering drugs were also registered. The patients were screened using local methods and devices but guidelines were available in order to ensure the use of similar methodol-
HbA1c values were converted to the DCCT standard levels calibrated with the HPLC Mono-S method. In this study, all HbA1c values were converted to the DCCT standard levels using the formula: HbA1c (DCCT) = (0.923 × HbA1c (Mono-S)) + 1.345; $R^2 = 0.998$ (12).

Blood pressure (BP) is registered as the mean of two readings (Korotkoff phases 1–5) with the patient sitting or lying down, using a cuff of appropriate size. These recommendations have been endorsed by the NDR [9]. Hypertension (current World Health Organisation definition) was defined as antihypertensive treatment, or untreated systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg [12]. Hyperlipidaemia was defined as lipid-lowering treatment, or untreated with total cholesterol ≥ 4.5 mmol/l and/or triglycerides ≥ 1.7 mmol/l. A smoker was defined as a patient smoking one or more cigarettes per day, or using a pipe, or who had stopped smoking within the past 3 months.

The 10-year absolute risks of coronary heart disease (CHD) and stroke according to the UKPDS risk engine model were evaluated in all participating patients [13,14]. CHD was defined as the occurrence of fatal or non-fatal myocardial infarction or sudden death. The risk of CHD in the next $t$ years, with diabetes duration $T$ years is [14]:

$$R_T(t) = \exp[-q \times 1.078^T \times (1 - 1.078^t)/(1 - 1.078)]$$

where:

$$q = 0.0112 \times 1.059^{\text{age-duration}-55} \times 0.525^{\text{sex}} \times 1.35^{\text{smoking}} \times 1.144^{\text{HbA1c}-6.72} \times 1.073^{(\text{sbp}-135.7)/10} \times 3.11^{(\text{nlog(total cholesterol/HDL cholesterol})-1.59}$$

Exp raises the number e to the specified expression, sex is 0 for males and 1 for females, and smoking is 0 for non-smokers and 1 for smokers, nlog is the natural log of the ratio of total cholesterol: HDL cholesterol. The correction factors were adjusted for regression dilution as described in the UKPDS [13]. Stroke was defined as either fatal with death attributed to stroke, or non-fatal with neurological deficit symptoms or signs persisting for more than 1 month, not distinguishing between ischaemic, embolic or haemorrhagic strokes. The risk of stroke in the next $t$ years with diabetes duration $T$ years is [14]:

$$R_T(t) = \exp[-q \times 1.145^T \times (1 - 1.145^t)/(1 - 1.145)]$$

where:

$$q = 0.0186 \times 1.092^{\text{age-duration}-55} \times 0.700^{\text{sex}} \times 1.547^{\text{smoking}} \times 1.06^{(\text{sbp}-135.5)/10} \times 1.111^{(\text{total cholesterol/HDL cholesterol})-5.11}$$

Only patients without previous CHD and stroke were included in these calculations.

2.1. Statistical methods

Results are presented as mean values ± one standard deviation (S.D.), proportions (%) and odds ratios. In the cross-sectional study in 2004, trends were analysed for mean values or proportions of clinical parameters in groups according to intervals of diabetes duration (Table 1 and Fig. 1), and multivariate regression was used to estimate significance levels for trends in means (effect test) and proportions (Wald chi²-test), allowing adjustment for age and gender. In the longitudinal studies from 1996 to 2004, with groups based on type of treatment (Table 2), HbA1c levels (Table 3) or study year (Fig. 2), significance levels were estimated for differences in mean values and proportions with one-way ANOVA t-test and Pearson chi²-test. Nominal logistic regression was used to estimate odds ratios adjusted for various covariates, with long-term change in HbA1c as dependent variable, and type of treatment (Table 2) or clinical characteristics (Table 3) as predictors, and significance levels for odds ratios estimated with the Wald chi²-test. A P-value < 0.05 was considered statistically significant. All statistical analyses were performed using JMP and SAS (SAS Institute, Cary, NC, USA).

3. Results

3.1. Cross-sectional study

Data from patients with varying duration of diabetes in the cross-sectional survey in 2004 (N = 61,890) were analysed regarding proportions of different hypoglycaemic treatments (Fig. 1). Treatment with diet only or OHA in monotherapy decreased sharply, from 85% to 24%, with increasing diabetes duration from 1–5 years to > 20 years. The use of insulin therapy alone or combined with OHA increased, from 15% to 76%. As can be seen in Table 1, the mean HbA1c value increased significantly with longer duration of diabetes, especially in patients treated with insulin only or in combination with OHA. There was a significant decrease in mean BMI in all groups of patients with longer diabetes duration, except with insulin in monotherapy where BMI showed a tendency to increase. However, the frequency of obesity in all patients remained high, around 30–40%. The frequency of hypertension was also high (80–92%), and only 30–25% of the patients reached the BP goal < 130/80 mmHg, the proportion decreasing with longer duration. Hyperlipidaemia was even more common (92–93%), and the treatment goals (total cholesterol < 4.5 mmol/l and LDL cholesterol < 2.5 mmol/l) were reached by only 29–36% and 34–43% of the patients, respectively, while 53–59% of the patients reached triglyceride levels < 1.7 mmol/l. The mean 10-year risk of CHD increased from 19% to 39%, and the mean 10-year risk of stroke increased from 9% to 41% in groups with increasing duration of diabetes. Interestingly, there were significant differences in clinical characteristics between younger and older newly diagnosed patients: patients under 50 years of age were considerably more obese, they also had higher mean HbA1c and were more often
All patients, followed from 1996 to 2004, patients with HbA1c < 7.3% at baseline and at follow-up (N = 892). A logistic regression analysis, with change in HbA1c as the dependent variable, revealed that a lower BMI and non-smoking in 1996, and changes in diabetes treatment from 1 year to the next, as shown in Fig. 2. The HbA1c levels preceding the addition of insulin to OHA, or preceding the change from OHA to insulin monotherapy, decreased by about 1% unit from 1996 to 2003. These HbA1c levels were clearly higher than the HbA1c levels in the diet-treated group, who later also received OHA, or in the group remaining on OHA monotherapy.

In the 8-year prospective analysis of 4742 type 2 diabetic patients, followed from 1996 to 2004, patients with HbA1c < 7.3% at baseline and at follow-up (N = 1178) were compared with all other patients (Table 3). The same analysis was also performed on data from patients showing an increase in HbA1c from < 7.3% at baseline to > 7.3% at follow-up (N = 675), as well as those showing a decrease in HbA1c from > 7.3% at baseline to < 7.3% at follow-up (N = 892). A logistic regression analysis, with change in HbA1c as the dependent variable, revealed that a lower BMI and non-smoking in 1996, and weight reduction during the study period were independent predictors of persisting good metabolic control, also indepen-

3.2. Longitudinal study

A longitudinal study of 3235 type 2 diabetic patients was performed to analyse the long-term effects of antihyperglycaemic treatment (Table 2). The highest proportion of patients with a decrease in HbA1c greater than 1% unit from 1996 to 2004 was seen among patients treated with OHA combined with insulin from baseline to follow-up (35.5%). A slightly lower proportion was seen in patients with OHA at baseline and insulin added during the study period (29.7%). The lowest proportion was seen in patients with unchanged OHA monotherapy from baseline to follow-up (23.8%). These results were confirmed after calculation of odds ratios, comparing insulin-treated patients with patients on OHA only, after adjustment for age, sex, diabetes duration, BMI, smoking, use of antihypertensive agents in 1996, and change in BMI from 1996 to 2004.

We also analysed the mean levels of HbA1c that led to changes in diabetes treatment from 1 year to the next, as shown in Fig. 2. The HbA1c levels preceding the addition of insulin to OHA, or preceding the change from OHA to insulin monotherapy, decreased by about 1% unit from 1996 to 2003. These HbA1c levels were clearly higher than the HbA1c levels in the diet-treated group, who later also received OHA, or in the group remaining on OHA monotherapy.
dently of type of hypoglycaemic treatment. In patients with decreasing HbA1c from 1996 to 2004, weight reduction during the period and smoking in 1996 were statistically significant independent predictors of the HbA1c effect. Weight increase from 1996 to 2004 predicted deterioration in HbA1c levels during the period.

4. Discussion

This study shows that the proportion of Swedish type 2 diabetic patients with insulin treatment (monotherapy or combined with OHA) increased considerably with longer duration of diabetes, from 31% after 5 years to 75% after more than 20 years’ duration of diabetes. It also demonstrates that the glycaemic control deteriorated, particularly among the insulin-treated patients in this group. Thus, the recommended HbA1c goal (< 7.0%) was reached by less than one-third of the insulin-treated patients with 6 years duration of diabetes or more, in spite of the institution of changes of the antihyperglycaemic treatment at lower HbA1c levels during the follow-up period.

Early addition of individualised insulin treatment is generally advocated today if the treatment goals are not reached [15], since several clinical trials have clearly documented the positive effect of insulin treatment in reducing HbA1c in patients inadequately treated with sulphonylurea or metformin [16,17]. The patients who managed to achieve a decrease in HbA1c of more than 1% unit during the 1996–2004 period were significantly more frequent among those with insulin added to OHA during the period (30%), or among those with OHA combined with insulin throughout the period (32–36%), compared with patients on long-term treatment with OHA only (24%). The actual types of OHA have only been recorded in the NDR since 2002. Thus, no conclusions can yet be drawn concerning glycaemic effects of different OHA.

The longitudinal study also demonstrated that complementary insulin treatment was instituted at a clearly lower HbA1c level during later years than in 1996–1997. In patients on OHA...
during the period 2001–2004, mean HbA1c values of less than 8% initiated a change to insulin treatment as monotherapy or as a complement to OHA, while in 1996 a mean HbA1c value of 8.8% caused a similar change, a difference of about 1% unit. Thus, the recommendations of earlier addition of insulin seem to have caused a change in the treatment of type 2 diabetic

**Table 3**

Univariate comparison of mean values and proportions of predictors for long-term development of HbA1c in three groups of type 2 diabetic patients

<table>
<thead>
<tr>
<th>A. Predictors</th>
<th>1. HbA1c &lt; 7.3% in 1996 and HbA1c &gt; 7.3% in 2004 (N = 1178)</th>
<th>2. Other patients (N = 3564)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age1996 (years)</td>
<td>62.8 ± 11</td>
<td>61.4 ± 10</td>
<td>1.01 (1.01–1.02)</td>
</tr>
<tr>
<td>Duration1996 (years)</td>
<td>5.9 ± 6.2</td>
<td>8.7 ± 6.7</td>
<td>0.95 (0.94–0.96)</td>
</tr>
<tr>
<td>BMI1996 (kg/m²)</td>
<td>27.9 ± 4.6</td>
<td>28.4 ± 4.9</td>
<td>0.95 (0.93–0.96)</td>
</tr>
<tr>
<td>BMI2004–BMI1996 (kg/m²)</td>
<td>–0.5 ± 2.4</td>
<td>0.2 ± 2.7</td>
<td>0.90 (0.88–0.93)</td>
</tr>
<tr>
<td>Female gender (%)</td>
<td>45.1</td>
<td>44.1</td>
<td>0.93 (0.80–1.08)</td>
</tr>
<tr>
<td>Smoking1996 (%)</td>
<td>10.1</td>
<td>12.4</td>
<td>0.78 (0.62–0.98)</td>
</tr>
<tr>
<td>BP treatment1996 (%)</td>
<td>44.8</td>
<td>44.3</td>
<td>0.99 (0.86–1.16)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Predictors</th>
<th>1. HbA1c &lt; 7.3% in 1996 and HbA1c &gt; 7.3% in 2004 (N = 675)</th>
<th>2. Other patients (N = 4067)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age1996 (years)</td>
<td>60.6 ± 6.1</td>
<td>62.0 ± 11</td>
<td>1.00 (0.99–1.01)</td>
</tr>
<tr>
<td>Duration1996 (years)</td>
<td>6.0 ± 6.1</td>
<td>8.3 ± 6.7</td>
<td>0.96 (0.94–0.97)</td>
</tr>
<tr>
<td>BMI1996 (kg/m²)</td>
<td>28.6 ± 4.6</td>
<td>28.2 ± 4.8</td>
<td>1.02 (0.99–1.03)</td>
</tr>
<tr>
<td>BMI2004–BMI1996 (kg/m²)</td>
<td>0.4 ± 2.6</td>
<td>–0.1 ± 2.7</td>
<td>1.10 (1.06–1.14)</td>
</tr>
<tr>
<td>Female gender (%)</td>
<td>41.5</td>
<td>44.9</td>
<td>0.84 (0.71–0.99)</td>
</tr>
<tr>
<td>Smoking1996 (%)</td>
<td>11.1</td>
<td>12.0</td>
<td>0.83 (0.64–1.09)</td>
</tr>
<tr>
<td>BP treatment1996 (%)</td>
<td>45.6</td>
<td>44.2</td>
<td>1.12 (0.94–1.33)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Predictors</th>
<th>1. HbA1c &lt; 7.3% in 1996 and HbA1c &gt; 7.3% in 2004 (N = 892)</th>
<th>2. Other patients (N = 3850)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age1996 (years)</td>
<td>63.7 ± 9</td>
<td>61.4 ± 10</td>
<td>1.02 (1.01–1.03)</td>
</tr>
<tr>
<td>Duration1996 (years)</td>
<td>8.8 ± 6.4</td>
<td>7.8 ± 6.7</td>
<td>1.02 (1.00–1.03)</td>
</tr>
<tr>
<td>BMI1996 (kg/m²)</td>
<td>28.5 ± 4.9</td>
<td>28.2 ± 4.8</td>
<td>1.00 (0.98–1.02)</td>
</tr>
<tr>
<td>BMI2004–BMI1996 (kg/m²)</td>
<td>–0.5 ± 2.9</td>
<td>0.1 ± 2.6</td>
<td>0.93 (0.90–0.96)</td>
</tr>
<tr>
<td>Female gender (%)</td>
<td>43.1</td>
<td>44.7</td>
<td>0.91 (0.78–1.06)</td>
</tr>
<tr>
<td>Smoking1996 (%)</td>
<td>13.0</td>
<td>11.6</td>
<td>1.34 (1.07–1.68)</td>
</tr>
<tr>
<td>BP treatment1996 (%)</td>
<td>49.2</td>
<td>43.3</td>
<td>1.10 (0.94–1.28)</td>
</tr>
</tbody>
</table>

Patients were grouped according to HbA1c values: A) low in 1996 and 2004 or not, B) increasing from 1996 to 2004 or not, C) decreasing from 1996 to 2004 or not. Adjusted odds ratios for the predictors at logistic regression are given, with the dependent variable HbA1c grouped as A, B or C. Adjusted odds ratios: each predictor was adjusted for all other predictors in Table and for type of hypoglycaemic treatment in 1996 (diet, OHA, insulin), and all continuous predictors increased with one unit. S.D.: standard deviation. CI: confidence interval. BP: blood pressure. Significance levels, by group 1 vs. group 2, for differences in mean values or frequencies (one-way ANOVA t-test or chi²-test), and for odds ratios (logistic regression: Wald chi²-test): 1 P < 0.001, 2 P < 0.01, 3 P < 0.05.

**Fig. 2.** Longitudinal analysis from 1996 to 2004 of mean HbA1c values in patients on different hypoglycaemic treatments preceding changes in hypoglycaemic treatment.

patients in Sweden since 1996, possibly partly explaining the high proportion of insulin therapy in patients with longer duration of diabetes, as shown by the cross-sectional survey in 2004. Furthermore, earlier initiation of insulin treatment, including new pharmaceutical agents such as insulin analogues, as well as adherence to national and international treatment guidelines [5,6] based on results from long-term prospective clinical studies [2,18,19], might also help to explain the slow but significant improvement in mean HbA1c levels among type 2 diabetic patients previously reported from the NDR [7].

The mean BMI levels were lower in patients with longer duration of diabetes. This effect, which was most pronounced in the patients on diet treatment, was also seen in patients on OHA as well as OHA and insulin combination therapy, but not in patients with insulin as the sole treatment. The 8-year prospective study revealed that both low BMI values and weight reduction were independent significant predictors of better long-term glycaemic control, regardless of age, sex, diabetes duration or type of hypoglycaemic treatment. These findings underline the importance of adopting a suitable lifestyle and weight reduction for better long-term glucose control, but may also reflect different clinical diabetes phenotypes with varying degrees of impairment in insulin secretion and sensitivity [20].

The frequency of hypertension was high even in patients with short duration of diabetes and even higher in patients with longer duration of diabetes. Only 25–30% of the patients reached BP levels lower than 130/80 mmHg. Furthermore, the frequency of hyperlipidaemia was generally high (around 90%), and no more than one-third of the patients reached the total cholesterol goal level. The high prevalence of these cardiovascular risk factors in patients with short duration of diabetes is quite alarming, as the incidence of macrovascular complications increases with duration, and more than half of the mortality in type 2 diabetes is related to cardiovascular disease [21, 22]. This was confirmed by the calculated mean 10-year risk of CHD (18% in patients with only 1–5 years’ duration of diabetes, 30% or more with > 16 years duration of diabetes). Calculation of the 10-year risk of CHD and stroke may thus be valuable in clinical practice. The Third Joint Task Force of European and Other Societies on Cardiovascular Disease Prevention in Clinical Practice has suggested a definition of a high 10-year risk of CHD of ≥ 20%, calculated as either fatal or non-fatal according to the UKPDS risk engine model used in this study [6].

Fifty-nine percent of the newly diagnosed type 2 diabetic patients under 50 years of age were obese, underlining obesity as a strong risk factor for the development of type 2 diabetes [23]. Similarly, a recent American study of 2437 newly detected type 2 diabetic patients in 1996–1998 showed an inverse relation between BMI and age of onset [24], suggesting that there is no BMI threshold determining the risk of diabetes, but rather a gradual increase of the risk.

Only about 2% of the patients in the cross-sectional study were under 40 years of age, and patients were excluded if data concerning onset age of diabetes were missing. Some non-obese patients, however, may have latent autoimmune diabetes in adults (LADA). A previous Swedish survey reported that autoimmune markers were detected in 8–10% of the patients with clinical type 2 diabetes [25]. However, the mean age of diabetes debut was 55 years among insulin-treated and 60 years among patients treated with OHA, and only 10% had onset of diabetes below 44 years of age. Hence, less than 8% of the patients epidemiologically classified as type 2 diabetic in the NDR may have LADA. The majority of Swedish diabetes health care centres report to the NDR, and the mean number of registered patients was 162 per participating unit. The patients participating in the cross-sectional study in 2004 should correspond to about a quarter of all diabetic patients in Sweden, since the prevalence of diabetes in Sweden was 3.2% at the beginning of the 1990s with an estimated 6% annual increase [26,27]. Taken together, it seems likely that this cross-sectional survey was fairly representative of Swedish type 2 diabetic patients.

To conclude, this study demonstrates that patients with long duration of diabetes in 2004 were frequently prescribed insulin treatment in order to improve glycaemic control, which usually deteriorates over time. Thus, the HbA1c levels leading to complementary insulin treatment decreased significantly from 1996–1997 to 2001–2003, which may also help explain the previously reported slow but gradual improvement of mean HbA1c levels in the NDR from 1996 to 2003. However, there is still a gap between the mean HbA1c levels in the DM2 patients and the recommended target levels, probably reflecting insulin resistance, and insufficient hypoglycaemic effects of the currently available therapeutic options. Our finding of low BMI and decrease in BMI as predictors of good long-term HbA1c control underlines the need for intensified lifestyle measures and weight reduction.

Acknowledgments

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References