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Original research

Perceived diabetes status is independently associated with glucose monitoring behaviour among type 2 diabetes mellitus patients☆

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ABSTRACT

Aims: To investigate if patients' perceptions of their diabetes status is related to blood glucose self-monitoring (SMBG) behaviour, independent of self-reported disease severity.
Methods: The setting of this study was a cross-sectional study among 1561 patients, 18 years or older, who filled at least two prescriptions for any glucose lowering drug between March 2002 and 2003 in the Netherlands. Using a 30-item self-administered questionnaire, data on self-monitoring behaviour (frequency of test strip use and objective of self-monitoring), perceived diabetes status and disease severity were gathered. Type 1 diabetes mellitus patients were excluded. We used logistic regression to calculate odds ratios (OR) and their 95% confidence intervals (CI).
Results: About 54% of the patients ($n = 841$) returned evaluable questionnaires. After exclusion of 97 type 1 diabetes mellitus patients, 744 type 2 diabetes mellitus patients were included. Practising SMBG was more common among patients who rated their diabetes status as poorly or moderately controlled compared to those who rated it (very) well-controlled (OR 1.93; 95% CI: 1.20–3.12). A better perceived diabetes status was more likely in those who performed SMBG infrequently compared to those who performed SMBG frequently (p-value for trend = 0.001). Self-reported factors of disease severity and personalised objectives did not affect these associations considerably.
Conclusions: Among type 2 diabetes mellitus patients, SMBG behaviour is associated with patients' perceptions of diabetes status, irrespective of the self-reported disease severity.

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1. Introduction

Reducing hyperglycemia is an important factor in the prevention of diabetic complications [1,2]. Lowering blood glucose levels can be achieved through different pharmacological and non-pharmacological treatments. Patient education on self-management of diabetes is considered an integral component of all diabetes care plans [3].

One of the key elements of self-management is self-monitoring of blood glucose (SMBG) [4]. Factors related to the frequency of self-monitoring are use of insuline and experiencing hypoglycemic events [5–9]. In practice, personal objectives of self-monitoring are strongly correlated with the way type 1 and type 2 diabetes is treated. Both Dutch and international diabetes care standards state that SMBG is especially important in insulin treated patients [5,10]. Patients who start with insuline are instructed how to perform SMBG. Once patients are well-controlled they are advised to decrease the self-monitoring frequency [5].

However, other factors may also influence self-monitoring behaviour. For example, a patient's perception of the diabetes status could explain the association between the clinical situation and self-monitoring behaviour. Personal illness models have been proposed as an important predictor of the level of self-management [11]. However, research into the relevance of patients' perceptions of their disease on self-monitoring is limited. Our aim was to determine if patients' perceptions of their diabetes status are associated with self-monitoring behaviour, irrespective of self-reported disease severity.

2. Patients and methods

2.1. *Setting and study population*

We conducted a cross-sectional survey of diabetic patients, aged 18 years and older and living in the Netherlands. Community pharmacies were invited to participate in the study through the professional journal of Dutch pharmacists. Pharmacists were asked to send the complete, anonymised medication history between March 2002 and 2003 of all patients who collected at least one prescription of an oral hypoglycemic agent (OHA) or an insulin in that period. From this set we selected all current users of glucose lowering drugs, defined as all patients who received at least two prescriptions of OHAs, two prescriptions of insulin or one prescription of insulin and one of an OHA between March 2002 and 2003. In each pharmacy, we made a random selection of eight percent of all current users. To make sure that we had enough respondents performing SMBG, we randomly selected 39 pharmacies to include – at random – an additional five insulin users. Previous studies show that insulin users are more likely to practice SMBG than patients using oral hypoglycemic agents [12]. The pharmacists included only those patients who were alive at March 1st, 2003. Furthermore, they excluded all patients who were known to have continuous nursing supervision (i.e. patients living in a nursing home or psychiatric ward) or did not understand Dutch. The participating pharmacists sent the selected patients a questionnaire, which could be returned to the researchers anonymously. In the analyses, we also excluded all patients of whom the result on the question about the type of diabetes was missing.

2.2. *Measurements*

Even though a variety of instruments on measuring diabetes-related quality of life, diabetes self-care activities and effectiveness of treatment have been used in the literature, we chose to construct a new questionnaire for two reasons. First, most studies were performed in English-speaking populations, introducing linguistical difficulties, differences in social context and processes in diabetes care when translating the items. Secondly, none of the instruments measuring frequency of test strip use (our main outcome) have been validated. We used a Dutch questionnaire from the Netherlands Institute for Health Services Research (NIVEL) as a starting point in developing our instrument [13]. This instrument measures the quality of care from the perspective of people with diabetes.

Our questionnaire, consisting of 30 items, explored a patient's usage pattern of blood glucose test strips and its determinants. All patients who responded having used test strips in the period of 01-2003 to 03-2003 were classified as performing SMBG. In this group, we defined test strip users who performed SMBG infrequently (one or less than one test strip per day) and those who were frequent users (more than one test strip per day).

Since we were not primarily interested in the different domains of a patient's perception of his diabetes status, we measured this with a single question. Patients could rate their diabetes status as very poorly or poorly controlled, moderately controlled, well-controlled, and very well-controlled. Data on indicators of disease severity were also collected and comprised last known HbA1c, occurrence of severe hypoglycemic events (defined as an event requiring assistance of someone else), duration of diabetes and the presence of diabetes-related complications (self-reported nephrological, neurological or visual problems). Co-morbidity was analysed using the chronic disease score [14], ranging from 0 for patients without co-morbidity to a maximum of 35. We also asked patients how they responded when they observed a hypoglycemic or hyperglycemic value. We used the following indicators as a proxy for the individual objective of self-monitoring: type of diabetes, type of glucose lowering drug treatment, performing glucose curves and self-regulation of insulin needs. These indicators were chosen because they were likely to be associated with different goals of SMBG. All questions explicitly related to the patient's situation in the previous 2 months. Furthermore, the questionnaire gathered data on patient characteristics.

The questionnaire was pre-tested by ten diabetic patients practicing self-monitoring, who were recruited in three different pharmacies. Their community pharmacist considered these patients to be representative of other diabetic patients in the pharmacy. The questionnaire was found to be comprehensible and relevant.

The pharmacy medication history was used to determine which glucose lowering drugs were prescribed between March 2002 and 2003.

2.3. *Analyses*

In the first analysis we studied the association between self-reported diabetes status and performing SMBG (categorised as yes or no). We adjusted for potential confounders that have been associated with test strip use in previous studies: age, gender, duration of diabetes, type of glucose lowering treatment, self-reported HbA1c, complications and self-reported hypoglycemic events [6–9,15]. In the second analysis, the study population was restricted to patients who reported performing SMBG. We assessed the relationship between self-reported diabetes status and frequency of test strip use. Because of the small sample size and the skewed distribution of some of the variables, we limited the multivariate analyses of this second analysis to a maximum of three co-variables (duration of diabetes, age and type of blood glucose lowering treatment). Finally, we investigated to what extent the association between self-reported status of diabetes and frequency of testing was influenced by (self-reported) markers of disease severity and individual self-monitoring objectives.

We used logistic regression to calculate these associations, expressed as odds ratios (OR) and their 95% confidence intervals (CI). All data were analysed using SPSS Version 11.0.

Table 1 – Characteristics of type 2 diabetes mellitus patients in the study

Patient characteristics	
Male gender	368 (49.5%)
Median age (IQR)[a]	67.0 (16.0)
Member of patient organisation	
Yes	94 (12.8%)
No	640 (82.2%)
Median chronic disease score (IQR)[a]	5.0 (4.0)
Median duration of diabetes (IQR)[a]	6.0 (9.0)
Use of blood glucose lowering drugs	
Current blood glucose lowering drugs	
Insulin	146 (19.6%)
Oral hypoglycemic agents	454 (61.0%)
Both insulin and oral hypoglycemic agents	144 (19.4%)
Recent change in glucose lowering drug use[b]	
Yes	221 (30.7%)
No	499 (69.3%)
Self-reported indicators of disease severity	
Self-reported HbA1c	
<7.5%	170 (24.3%)
7.5–8.5%	230 (32.9%)
>8.5%	108 (15.5%)
Unknown	191 (27.3%)
Self-reported presence of visual, nephro- or neuropathic complications	
None	199 (26.7%)
At least one	545 (73.3%)
Self-reported severe hypoglycemic event	
Yes	48 (6.6%)
No	683 (93.4%)
Perception of diabetes status	
(Very) poorly controlled	3.3% (24)
Moderately controlled	19.5% (142)
Well-controlled	62.5% (455)
Very well-controlled	14.7% (107)
Currently self-monitoring blood glucose	
Yes	371 (49.9%)
No	372 (50.1%)
Frequency of test strip use	
Once or less per day	212 (57%)
More than one per day	103 (28%)
Non-classifiable[c]	59 (16%)

[a] IQR, interquartile range (absolute difference between 25th percentile and 75th percentile).
[b] Dosage change, switch to or adding of other glucose lowering drug between 01-2003 and 03-2003.
[c] Data were not available or reported data did not match with response on other questions on test strip usage pattern.

3. Results

3.1. Study population

We collected the medication history of 16,440 users of antidiabetic agents in 61 pharmacies. A total of 1561 current users were sent the questionnaire. These randomly selected patients were comparable on age, gender and type of antidiabetic drug use to the total population of 16,440 patients (data not shown).

In total 1048 (67.1%) questionnaires were returned (Fig. 1). Of these 1048 respondents, we excluded 4 patients because they had gestational diabetes, 97 type 1 diabetes mellitus patients, 59 patients because they were hospitalized use of insuline in the 2 preceeding months, or because they had missing data on type of diabetes (82 patients) and SMBG or recent hospitalisation (62 patients).

There was no statistically significant difference between responders and non-responders in the proportion of men, glucose lowering drug treatment or age. Patients excluded from the study were comparable to included respondents on gender, glucose lowering drug use and age.

Of type 2 patients, about 20% used insulin and another 20% used both insulin and OHAs during the study period (Table 1). Nearly 7% of these type 2 patients and reported a severe hypoglycemic event and about three out of ten patients reported having at least one diabetes-related complication. Most patients rated their diabetes status as well-controlled. Still, a quarter of the type 2 patients perceived it as moderately or poorly controlled. Among the type 2 patients, 50% (371) had used test strips in the 2 months before filling in the questionnaire.

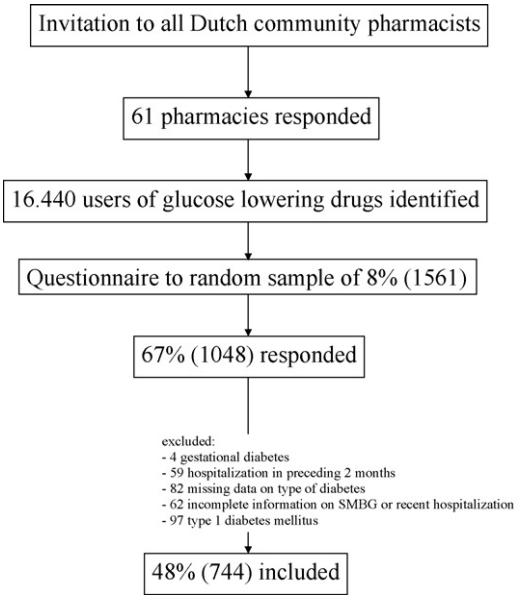

Fig. 1 – Flow chart of patient recruitment.

3.2. Factors associated with performing SMBG

Table 2 reports the association between characteristics of type 2 patients (including perception of diabetes status) and whether or not a patient performed SMBG. Patients who reported a moderately or poorly controlled diabetes status were almost two times more likely to use test strips compared to patients reporting to be well- or very well-controlled (OR = 1.93; 95% CI = 1.20–3.12; 30% versus 16%). Both the indicators of disease severity and type of glucose lowering treatment did only marginally influence the association between the perception of diabetes status and performing SMBG, as shown by the small difference between the crude and the adjusted odds ratio.

3.3. Factors associated with frequency of test strip use

Among the 467 patients who performed SMBG, 239 used one or less than one test strip per day (infrequent users). We categorised 153 patients as frequent users (more than one test strip per day).

Table 2 – Association between a patient's perception of diabetes status, self-reported disease severity and performing self-monitoring of blood glucose among type 2 diabetes mellitus patients

	Crude OR (95% CI)	Adjusted OR[a] (95% CI) (n = 611; 319 events)
Patient's perception of diabetes status		
Poorly or moderately controlled	2.17 (1.51–3.11)	1.93 (1.20–3.12)
Well-controlled or very well-controlled {reference}	1.00	1.00
Self-reported indicators of disease severity		
Self-reported value of last HbA1c {reference: <7.5%}		
7.5–8.5%	2.07 (1.26–3.41)	1.55 (0.73–3.31)
>8.5%	2.47 (1.63–3.72)	1.44 (0.75–2.74)
Unknown	2.54 (1.65–3.90)	0.99 (0.48–2.05)
Presence of visual, nephro- or neuropathic complications {ref.: no complications}	2.98 (2.11–4.22)	1.89 (0.95–3.24)
Self-reported recent, severe hypoglycemic event {ref.: no event}	6.41 (2.84–14.5)	2.51 (0.65–9.78)

[a] Odds ratios are adjusted for age, gender, duration of diabetes, type of glucose lowering treatment, self-reported HbA1c, complications and self-reported hypoglycemic events.

For type 2 patients, the association between testing frequency and perceived diabetes status is summarised in Table 3. Self-reported diabetes status was associated significantly with frequency of testing: 82% of all patients reporting a poorly controlled diabetes were frequent test strip users, compared to 30% of those who rated themselves as well-controlled (OR: 10.9; 95% CI: 3.02–39.7). Furthermore, 17% of the respondents with a very well-controlled diabetes status used test strips frequently (OR: 0.47; 95% CI: 0.20–1.13). Even though the latter result was not statistically significant, the Chi-square test for trend was ($p < 0.001$). Interestingly, the association did not change much when we adjusted for indicators of disease severity, performing glucose curves or type of glucose lowering treatment.

Indicators of disease severity were not significantly associated with frequency of testing in this study. Adjustment for differences in age, type of glucose lowering drug treatment and duration of diabetes had a limited effect on most associations.

4. Discussion

In this observational study, self-monitoring was associated with a patient's perception of diabetes status. Even after adjusting for recognised clinical factors for self-monitoring (disease severity and type of antidiabetic drug use), patients who performed self-monitoring rated their status less positive than patients who did not perform SMBG. Furthermore, among type 2 patients the frequency of test strip use was also associated with a patient's perceived diabetes status. This association too, did not change considerably when adjusted for disease severity and the personal objectives of self-monitoring.

The observed importance of clinical status and personal objectives is confirmed by previous studies [6–9,15,16].

One explanation for the association between self-monitoring frequency and perception of diabetes status could be the patient's mechanism for coping with negative results (blood glucose values that are either too high or too low). Negative results might be interpreted by the patients as poor control. Since patients who monitor are also more likely to find a blood glucose value that is out of the normal range, they are also more likely to perceive poorer control. In itself, a result indicating for example a hypoglycemic event, will probably induce more frequent measuring of blood glucose to evaluate the effectiveness of the patient's intervention. Current practice in the Netherlands strengthens this circular relationship; patients who are (clinically) well-controlled are advised to decrease the self-monitoring frequency, reducing the probability of finding a hypoglycemic or hyperglycemic value.

Our aim was to determine if, apart from clinical indicators of self-monitoring behaviour, patients' perceptions were associated with self-monitoring behaviour. Our questionnaire has only been validated on comprehensibility and completeness of the response categories. Results of a question on diabetes status cannot be regarded as a complete personal illness model. However, our study was not designed to elucidate the mechanism in which perception of diabetes status could influence self-monitoring behaviour. For this, further research into the domains of perceived diabetes status is warranted.

A limitation of our study is that most data were self-reported, which could have resulted in misclassification of respondents. Even so, data collection on performing SMBG,

Table 3 – Association between a patient's perception of diabetes status, self-reported disease severity and the frequency of test strip use among type 2 diabetes mellitus patients

	Crude odds ratio (95% CI)	Adjusted odds ratio[a] (95% CI)
Patients' perceptions		
Perception of diabetes status {reference: well-controlled diabetes status}[†]		
(Very) poorly controlled ($n = 17$)	10.9 (3.02–39.7)	10.6 (2.77–40.5)
Moderately controlled ($n = 81$)	1.38 (0.79–2.41)	1.55 (0.85–2.84)
Very well-controlled ($n = 42$)	0.47 (0.20–1.13)	0.52 (0.21–1.29)
Self-reported indicators of disease severity		
Self-reported value of last HbA1c {reference: <7.5%}		
7.5–8.5% ($n = 111$)	1.03 (0.48–2.19)	0.97 (0.42–2.26)
>8.5% ($n = 47$)	2.05 (0.87–4.84)	2.57 (1.00–6.64)
Unknown ($n = 84$)	1.62 (0.75–3.51)	1.70 (0.72–4.00)
Presence of visual, nephro- or neuropathic complications ($n = 115$) {ref.: no complications}	1.48 (0.91–2.40)	1.23 (0.73–2.10)
Self-reported recent, severe hypoglycemic event ($n = 34$) {ref.: no event}	0.85 (0.39–1.86)	0.65 (0.29–1.48)
Self-regulation of insulin need (only in insulin using patients) ($n = 44$) {ref. no self-regulation}	9.13 (3.48–24.0)	5.05 (2.59–9.82)
Measuring a hypoglycemic or hyperglycemic value ($n = 209$){ref.: no event}	3.77 (1.92–7.40)	3.88 (1.91–7.87)

The ORs are shown for frequent users versus infrequent users. Numbers behind the factors refer to patients who scored 'yes' on that item.

[†] p-Value for trend = 0.0001.

[a] Multivariate odds ratios are adjusted for age, type of glucose lowering drug treatment and duration of diabetes.

frequency of testing and patient characteristics is not very sensitive to misinterpretation. Furthermore, it is not likely that classification of the self-monitoring behaviour is biased by type or severity of diabetes.

The number of usable responses on frequency of test strip use can also be considered a limitation. Due to insufficient contrast, we could not clarify the association among patients with type 1 diabetes. We also had to limit the number of factors for which we could adjust in the analyses of the association between self-monitoring frequency and perception of diabetes status, since several determinants were highly correlated. Still, we observed a significant trend between perception of diabetes status and frequency of self-monitoring. Furthermore, the effects of the adjustments all pointed in same direction.

Our results show suggests that patients may not have a correct perception about their actual level of diabetes control. Therefore, providers of diabetes care should be aware that type 2 diabetes mellitus patients who are frequently testing their blood glucose may perceive their diabetes status as poor. These patients might need extra attention, since their perception of the diabetes status does not necessarily have to correspond with more objective measures of disease severity.

Conflict of interest

There is no conflict of interest with the current study.

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