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Glycemic control and its correlates in patients with diabetes in Venezuela: Results from a nationwide survey

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ABSTRACT

Aims: To determine the prevalence of inadequate glycemic control and its correlates in a large multicenter survey of Venezuelan patients with diabetes.

Methods: A cross-sectional study in a sample of adult patients with diabetes, attending health centers in Venezuela. Information about diabetes, current medications, complications, and diet were obtained by trained interviewers, using a standardized questionnaire. HbA_{1c} was measured by high-performance liquid chromatography in a central laboratory. Patients with $HbA_{1c} \geq 7\%$ were considered to have inadequate glycemic control.

Results: Overall 4075 patients were surveyed, 349(8.6%) with type 1 diabetes (T1D) and 3726(91.4%) with type 2 diabetes(T2D). Subjects' mean age was 58 years, and 65% were female. The prevalence of inadequate glycemic control was 76%. Poor glycemic control was more common in T1D patients (87%) than in those with T2D(75%), $p < 10^{-4}$. Satisfaction with current diabetes treatment was associated with improved glycemic control among non-insulin-treated patients with T2D, but gender, multi-professional care, and participation in a diabetes education program were not.

Conclusions: Despite clinical evidence supporting tight control of diabetes, few diabetic patients in Venezuela met recommended glycemic control targets. This may contribute to increased rates of diabetic complications. Our findings support the public health message of implementation of early, aggressive management of diabetes.

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1. Introduction

The prevalence of diabetes is increasing due, among other reasons, to diet changes, aging, urbanization, and increasing prevalence of obesity and physical inactivity. In 2000, the World Health Organization indicated there were ~170 million people with diabetes, and estimated that the number of cases of the disease worldwide will have more than doubled to 366 million by 2030 [1]. In the Americas, the number of diabetes cases will change from 33 million to 66.8 million in the same period [1]. Diabetes is associated with serious long-term complications including microvascular and macrovascular disease, which impose an additional socio-economic burden and account for substantial healthcare costs [2,3].

Improved glycemic control in people with diabetes reduces the risk of long-term complications. The Diabetes Control and Complications Trial [4] and the United Kingdom Prospective Diabetes Study [5] have provided evidence for the benefits of tight and sustained glycemic control among type 1 and 2 diabetic patients. These and other studies emphasized the central role of consistently managing HbA_{1c} levels in patients with diabetes, as a result some professional associations proposed clinical guidelines in the range of 6.5–7.0% to motivate health professionals and patients to constantly manage blood glucose levels [6,7]. Despite the numerous advances achieved in diabetes control and evaluation, the management of such a complex disease remains challenging. Recent epidemiological data from various international regions show most patients with diabetes are not controlled to recommended HbA_{1c} targets [8–16].

There is scarce and limited data about the epidemiology of diabetes in Venezuela. Estimates of the prevalence of diabetes in the urban Venezuelan population range from 3.8 to 7.3%, and there is evidence that it is increasing [17]. Information on the metabolic control of patients with diabetes is essential for planning programs on diabetes management. Our goal in this study was to estimate the prevalence of inadequate glycemic control and its correlates in a large multicenter survey of adult patients with diabetes in Venezuela.

2. Subjects, materials and methods

2.1. Setting and participants

This was a cross-sectional and nationwide survey conducted from January to June 2007 in ambulatory and medical services for type 1 and/or type 2 diabetes patients in all but two regions in Venezuela (excluded because of low population density). The study was center based, given that it was not feasible to contact patients directly, and designed to obtain detailed information in the largest possible sample of diabetic adults in Venezuela. For the selection of diabetes centers, we asked two Venezuelan diabetes associations (Venezuelan Endocrinology Society and La Fedeación Nacional de Asociaciones y Unidades de Diabetes—FENADIABETES) to identify, in each of the regions studied, a minimum of four candidate centers from various registries, patient association lists, and professional information. These centers were to be chosen from those with longer experience in epidemiological research and where at least one hundred adult patients with diabetes were followed per month. According to these criteria, centers were selected in each of the following eight regions in Venezuela: Capital, Central, Llanera, Occidental, Nor-Oriental, Guayana, Andina and Zuliana. All thirty-two centers invited joined the study. The participating centers were classified as a university-affiliated hospital (15), a general public hospital (4), or not-for-profit private hospital (13).

A sample of all consecutive patients with diabetes mellitus attending each participating clinic during a 30-day period was selected. Eligible cases were adults aged 18 years or older, who had been previously diagnosed by a physician with either type 1 or type 2 diabetes before the survey. Patients who had participated in an intervention trial in the previous three months and women who reported a history of diabetes only during pregnancy were not included. Subjects were invited to participate in the study and those who agreed signed an informed consent form. Overall, the response rate was 92% (ranging from 85 to 98%). The study protocol was approved by a local ethics committee at each region, and was carried out in accordance with the principles of the Declaration of Helsinki as revised in 2000.

2.2. Data and specimens collection

Information about diabetes history, current medications, self-reported symptoms and co-morbidities, complications, dietary habits, clinical parameters (fasting blood glucose, HbA_{1c}, and body mass index—BMI) were gathered using a structured questionnaire. In addition, data on factors related to treatment processes such as: actual treatment for diabetes, adherence to treatment, and access to multi-professional care (defined as health care delivered by a team comprised by at least, an Endocrinologist or diabetes specialist, a Nurse, and a Dietitian or Nutritionist) were obtained. We also asked information on self-perception of glycemic control (using a scale with four levels: poor, fair, good and very good), and satisfaction with current diabetes treatment (using a single global question: "If you were to spend the rest of your life with your diabetes treatment the way it is today, how would you feel about this? Very satisfied, somewhat satisfied, neither dissatisfied nor satisfied, somewhat dissatisfied, or very dissatisfied"). The questionnaire was piloted on a sample of volunteer patients to refine the wording of items and ensure clarity of the text. All items were assessed for face validity by health survey experts. The individual interviews lasted an average 20–25 min, and the sessions occurred in a private room.

The study questionnaire was administered in person by a team of trained and certified interviewers (not part of the local center staff). They were given an orientation on the protocol and specific details concerning participation in the study, and prior to study commencement, they all carried out practice sessions with authentic respondents. These preliminary interviews were observed and critiqued by the investigators. The interview guides were developed from a review of the literature and contained sections of questions that addressed the major areas to be explored by the study.

A peripheral blood sample was collected for the measurement of HbA_{1c} in every patient. All measurements of HbA_{1c} were made with an automated high-performance liquid

Table 1 – Selected characteristics (%) of 4075 patients according to diabetes type, Venezuela, 2007.

	Diabetes	
	Type 1 (n = 349)	Type 2 (n = 3726)
Age in years		
18–29	27.0	0.9
30–39	17.5	3.5
40–49	16.0	15.0
50–59	17.5	32.4
60–69	14.6	27.8
≥70	7.4	20.4
Female	60.2	65.1
Current marital status		
Married/living with partner	45.6	55.6
Single, never married	41.8	23.1
Divorced/separated	6.9	7.9
Widowed	5.7	13.4
Racial/ethnic background		
White	52.6	46.5
Mixed	43.4	49.2
Black	2.0	3.6
Other	2.0	0.7
Education		
Primary school or less	35.7	52.8
Secondary/high school	34.0	31.5
At least some college	30.3	15.7
Venezuelan region		
Nor-Oriental	22.6	11.6
Central	16.6	12.2
Llanera	13.5	12.5
Zuliana	12.0	12.4
Andina	10.6	12.6
Guayana	9.5	12.8
Occidental	9.2	12.8
Capital	6.0	13.1
Body mass index (kg/m^2)		
Underweight (≤18.5)	3.0	0.8
Normal weight (18.6–24.9)	46.1	25.3
Overweight (25.0–29.9)	35.0	39.4
Obese (30.0–39.9)	14.4	30.2
Morbidly obese (≥40.0)	1.5	4.3

chromatography (Variant Turbo-BioRad) in a central laboratory. The normal value range is 4.0–6.0%.

2.3. *Statistical analysis*

All collected data were analyzed using a public domain statistical program (EPI INFO version 3.04d, Centers for Disease Control & Prevention, USA; World Health Organization, Geneva, Switzerland). The number and percent of diabetic patients who achieved glycemic control was calculated using a cutpoint $HbA_{1c} < 7.0\%$, as defined in the American Diabetes Association standards of medical care for persons with diabetes [18]. The values of HbA_{1c} were also classified into three arbitrary categories: <7.0%, 7.0–8.9% and ≥9.0%. All data presented were stratified by diabetes type (1 or 2). In some analysis, the data on type 2 diabetes were further stratified by therapeutic regimen in two categories: insulin-treated and non-insulin-treated. Basic descriptive statistics and frequency calculations were performed on all variables; a chi-square test was used to assess differences in answers by categories of stratifying variables, with statistical significance at 5%. All statistics analyses were performed using the "R" statistical software (Version 2.5.0; The R Foundation for Statistical Computing, Vienna, Austria).

3. Results

Overall 4075 patients were included in this survey, 349 (8.6%) with type 1 and 3726 (91.4%) with type 2 diabetes. Table 1 depicts the characteristics of the study participants. The age varied from 18 to 93 years, approximately 45% of the patients with type 1 diabetes were less than 40 years old, while the majority of the patients with type 2 diabetes (96%) were aged 40 years or older. Most of the survey participants were females, married or living with partner, and had attained primary school education or less, regardless of diabetes type. The distribution of BMI categories revealed that 46% of the subjects were classified as normal weight and 16% as obese among the patients with type 1 diabetes, compared to 26% and 35%, respectively, among the patients with type 2 diabetes.

Table 2 – Distribution (%) of HbA_{1c} in 4075 patients by type, treatment and duration of diabetes in Venezuela, 2007.

HbA_{1c} (%)	Type 1 (n = 349)			Type 2 (n = 3726)								
				Insulin-treated (n = 841)			Non-insulin-treated (n = 2885)			All (n = 3726)		
	<5 years	≥5 years	All[a]	<5 years	≥5 years	All[b]	<5 years	≥5 years	All[b]	<5 years	≥5 years	All[b]
<7.0	20.7	11.2	12.6	22.6	7.4	9.8	42.3	20.5	29.6	40.4	16.7	25.0
7.0–7.9	12.1	10.4	10.6	13.3	13.0	13.2	16.5	18.6	17.8	16.2	17.0	16.8
8.0–8.9	12.1	14.0	13.5	10.2	15.5	14.7	10.7	14.4	12.7	10.6	14.7	13.2
9.0–9.9	12.1	14.7	14.3	11.7	15.7	14.7	8.1	11.9	10.4	8.4	13.0	11.4
10.0–10.9	5.2	14.0	12.0	9.4	14.5	14.1	7.8	11.3	9.8	8.0	12.2	10.8
11.0–11.9	8.6	14.0	13.2	11.7	13.0	12.8	5.7	8.6	7.4	6.3	9.9	8.6
≥12.0	29.2	21.7	23.8	21.1	20.9	20.7	8.9	14.7	12.3	10.1	16.5	14.2

[a] $p < 0.05$.
[b] $p < 0.001$.

Table 3 – Characteristics of patients with diabetes, according to HbA_{1c} value and diabetes type, Venezuela, 2007.

	Type 1					Type 2 (insulin-treated)					Type 2 (non-insulin-treated)				
	n	HbA_{1c} < 7.0%	HbA_{1c} 7.0–8.9%	HbA_{1c} > 9.0%	*p*-Value[a]	*n*	HbA_{1c} < 7.0%	HbA_{1c} 7.0–8.9%	HbA_{1c} > 9.0%	*p*-Value[a]	*n*	HbA_{1c} < 7.0%	HbA_{1c} 7.0–8.9%	HbA_{1c} > 9.0%	*p*-Value[a]
Gender															
Male	139	18 (12.9)[b]	39 (28.1)	82 (59.0)	0.33	275	35 (12.7)	91 (33.1)	149 (54.2)	0.001	1025	292 (28.5)	337 (32.9)	396 (38.6)	0.13
Female	210	26 (12.4)	45 (21.4)	139 (66.2)		566	47 (8.3)	144 (25.4)	375 (66.3)		1860	561 (30.2)	544 (29.2)	755 (40.6)	
Venezuelan region															
Capital	21	4 (19.0)	4 (19.0)	13 (62.0)	0.20	119	17 (14.3)	25 (21.0)	77 (64.7)	0.01	369	109 (29.5)	128 (34.7)	132 (35.8)	0.001
Central	58	11 (19.0)	17 (29.3)	30 (51.7)		120	11 (9.2)	37 (30.8)	72 (60.0)		334	107 (32.0)	103 (30.8)	124 (37.2)	
Llanera	47	8 (17.0)	16 (34.0)	23 (49.0)		182	21 (11.5)	71 (39.0)	90 (49.5)		283	110 (38.9)	87 (30.7)	86 (30.4)	
Occidental	32	2 (6.3)	7 (21.9)	23 (71.8)		81	5 (6.2)	22 (27.1)	54 (66.7)		397	112 (28.2)	108 (27.2)	177 (44.6)	
Nor-Oriental	79	7 (8.9)	13 (16.5)	59 (74.6)		62	4 (6.5)	14 (22.6)	44 (70.9)		370	100 (27.0)	112 (30.3)	158 (42.7)	
Guayana	33	3 (9.1)	8 (24.2)	22 (66.7)		74	5 (6.8)	13 (17.6)	56 (75.6)		402	109 (27.1)	127 (31.6)	166 (41.3)	
Andina	37	2 (5.4)	8 (21.6)	27 (73.0)		109	9 (8.3)	31 (28.4)	69 (63.3)		361	117 (32.4)	105 (29.1)	139 (38.5)	
Zuliana	42	7 (16.7)	11 (26.2)	24 (57.1)		94	10 (10.6)	22 (23.4)	62 (66.0)		369	89 (24.1)	111 (30.1)	169 (45.8)	
Health care by multi-professional team[c]															
Yes	179	22 (12.3)	45 (25.1)	112 (62.6)	0.89	460	41 (8.9)	119 (25.9)	300 (65.2)	0.16	1402	391 (27.9)	432 (30.8)	579 (41.3)	0.14
No	170	22 (12.9)	39 (22.9)	109 (64.2)		381	41 (10.8)	116 (30.4)	224 (58.8)		1483	462 (31.2)	449 (30.3)	572 (38.5)	
Self-perception of glycemic control in past 12 months															
Poor control	24	1 (4.2)	8 (33.3)	15 (62.5)	0.29	48	4 (8.3)	10 (20.8)	34 (70.9)	0.001	233	41 (17.6)	52 (22.3)	140 (60.1)	0.001
Fair control	118	13 (11.0)	23 (19.5)	82 (69.5)		313	16 (5.1)	82 (26.2)	215 (68.7)		1050	243 (23.1)	319 (30.4)	488 (46.5)	
Good control	158	22 (13.9)	40 (25.3)	96 (60.8)		377	43 (11.4)	109 (28.9)	225 (59.7)		1285	434 (33.8)	405 (31.5)	446 (34.7)	
Very good control	37	8 (21.6)	9 (24.3)	20 (54.1)		100	19 (19.0)	34 (34.0)	47 (47.0)		252	118 (46.9)	84 (33.3)	50 (19.8)	
Ever participated in diabetes health education group or program															
Yes	111	15 (13.5)	24 (21.6)	72 (64.9)	0.73	299	24 (8.0)	81 (27.1)	194 (64.9)	0.34	721	217 (30.1)	219 (30.4)	285 (39.5)	0.94
No	236	29 (12.3)	60 (25.4)	147 (62.3)		539	58 (10.8)	154 (28.6)	327 (60.6)		2157	635 (29.4)	658 (30.5)	864 (40.1)	

[a] Chi-square test.
[b] *n* (%).
[c] Comprised of at least: an Endocrinologist (or diabetes specialist), a Nurse, and a Dietitian (or Nutritionist).

The prevalence of inadequate glycemic control was 76% (3100/4075). The frequency distribution of HbA_{1c} values in the population studied according to type and duration of diabetes is shown in Table 2. Poor glycemic control was found more often in patients with type 1 diabetes (87%) than in those with type 2 (75%), $p < 10^{-4}$. However, the distribution of HbA_{1c} among patients with type 2 diabetes (insulin-treated) was similar to that found in patients with type 1 diabetes. Patients with type 2 diabetes (non-insulin-treated) were more likely to have a higher prevalence of adequate glycemic control (30%) when compared to patients with type 1 diabetes (13%) or type 2 diabetes (insulin-treated) (10%), $p < 10^{-6}$. After stratifying the data according to the duration of the disease, patients with either type 1 or type 2 diabetes lasting for five years or more were more likely to have worse control than those with less than five years of disease (Table 2).

Table 3 shows the frequency distribution for categories of HbA_{1c} values by selected characteristics and diabetes type. There was no significant difference in glycemic control according to gender, except for type 2 patients (insulin-treated), where females were less likely to have adequate glycemic control (8%) than males (13%), $p < 0.001$. Diabetic patients receiving care from a multi-professional team were equally likely to be classified in the top category of HbA_{1c} values (>9.0%) as patients not receiving such care, regardless of diabetes type. Among patients with type 2 diabetes, the self-perception of glycemic control was strongly associated with HbA_{1c} levels. Patients perceiving their glycemic control to be ''poor'' or ''fair'' were more likely to fall in the top category of HbA_{1c} values. Conversely, patients perceiving their glycemic control to be ''good'' or ''very good'' were more likely to have adequate glycemic control and to be classified in the lower category of HbA_{1c} values (<7.0%). Participation in a group or program that promotes diabetes health education was not associated with lower rates of increased HbA_{1c} values in patients with either type 1 or type 2 diabetes.

The relationship of glycemic control and self-reported satisfaction with current diabetes treatment is shown in Fig. 1. The more satisfied with their treatment the diabetic patients were the greater the rates of adequate glycemic control. This was shown in patients with type 2 diabetes (non-insulin-treated).

4. Discussion

To our knowledge, this is the largest multicenter, nationwide survey to estimate prevalence rates of inadequate glycemic control in Venezuela, and the first to evaluate these rates in patients with type 1 or type 2 diabetes. The overall prevalence of inadequate glycemic control in our study (76%) was high, and greater than previous estimates from other studies including type 1 and 2 diabetic patients in Germany (40%) [12], Denmark (51%) [13] and Kenya (61%) [14].

The highest rates of inadequate glycemic control were found in patients with type 1 diabetes (87%), but they were also elevated in patients with type 2 diabetes (75%). Among the latter, the subgroup of patients not treated with insulin presented relatively lower rates of poor glycemic control (70%), while patients with type 2 diabetes using insulin had a prevalence of inadequate glycemic control (90%) similar to that observed in patients with type 1 diabetes (87%). One survey by Arai et al. [19] in Japan and another study by Yu et al. [9] in Taiwan also reported lower mean levels of HbA_{1c} among patients not requiring insulin. These differences changed after we stratify the data by diabetes duration, but even among patients at earlier stage of diabetes (<5 years duration) insulin treatment is associated with worse control when compared to diet alone or combined with oral treatment, possibly due to more severe and more difficult to control diabetes in the former patients. Furthermore, patients using oral treatment (the major option in the group ''non-insulin-treated'') have a more simple to administer treatment option, which tends to be more effective under the conditions of daily life. It is also possible that diabetes in patients treated with insulin is more difficult to control because these subjects have a more severe

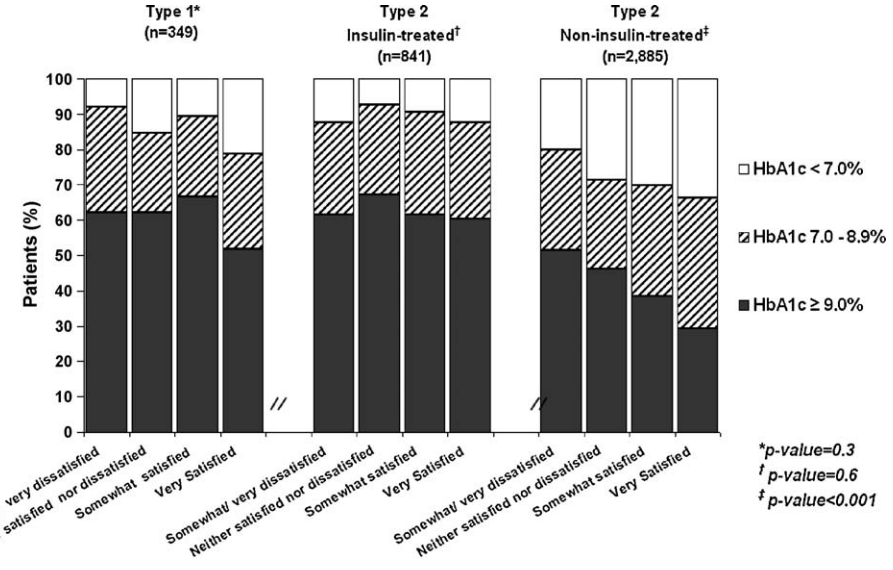

Fig. 1 – Relationship between self-reported global satisfaction with diabetes treatment and distribution of HbA_{1c} values, according to diabetes type, Venezuela, 2007.

disease. Indeed patients with type 2 diabetes when finally receiving insulin usually have a more severe stage of disease. Diabetes then is much more difficult to control than before.

The rates of inadequate glycemic control we found in patients with type 2 diabetes are higher than those reported in similar patients in Canada (49%) [16], the Netherlands (42%) [20], and in the United States, where estimates derived from the National Health and Nutrition Examination Survey (NHANES) were 63% (1999–2000), 51% (2001–2002), and 43% (2003–2004) [21]. However, large surveys including patients with type 2 diabetes in the United Kingdom (UK) ($N = 10,663$) [11], Canada ($N = 5569$) [22], and Brazil ($N = 5692$) [23] provided estimates similar to ours, 76%, 73% and 73%, respectively. Although these variations across studies may be true, they may also be due to differences in the populations surveyed, the methods of data collection, the measurements of HbA_{1c}, and the definitions of HbA_{1c} cutpoints for adequate glycemic control.

We found no significant difference in glycemic control by gender, except in the subgroup of patients with type 2 diabetes insulin-treated, where men achieved a better glycemic control. Similarly, in a study in a Pakistani Muslim diabetic population in Manchester, UK, women were worse than men in performing regular glucose measurements, in managing persistent hyperglycemia, and had also poorer glycemic control overall (HbA_{1c} 8.8% vs. 8.1%, $p < 0.05$) [24]. Results from a survey in Mexico have suggested that women have several social disadvantages, deterioration of healthy life, poor self-care and lack of solidarity that increases their vulnerability to reach glycemic control successfully [25]. However, several studies have failed to show significant gender differences related to self-care and control of type 2 diabetes [11,20–22].

In our data, multi-professional care was not associated with improved glycemic control in patients with either type 1 or type 2 diabetes. Similarly, a large, methodologically rigorous study by De Berardis et al. reported no significant difference in glycemic control when comparing primary with specialist diabetes care [26]. In contrast, a nationwide survey in 15,652 Japanese patients with diabetes found that the mean HbA_{1c} level for all patients treated by general practitioners was significantly lower than for those treated by the diabetes specialists ($6.8 \pm 1.2\%$ vs. $7.0 \pm 1.2\%$, $p < 0.001$) [19]. Most previous studies, however, have favored specialist diabetes care [20,22,27,28]. In the Pittsburgh Epidemiology of Diabetes Complications Study, specialist care was associated with higher levels of participation in diabetes self-care practices and lower values of HbA_{1c}, but in the multivariate analyses the lower HbA_{1c} levels observed in patients receiving specialist care were restricted to patients with an annual income >$20,000 [29]. Patients with diabetes receiving multi-professional care have greater access to other health care providers such as nurse educators or dietitians; this may lead to greater focus on glycemia management during each patient visit, or more aggressive use of glucose-lowering medications by specialists. On the other hand, patients with more severe diabetes or whose metabolic control is more difficult to achieve are more likely to be referred to specialist care, whereas mild cases of diabetes tend to be seen at primary care. In our analysis we have not controlled for disease severity, thus we can not rule out the lack of association might be due to this potential confounding.

It has been shown that poor numeracy skills are common in patients with diabetes, and that low diabetes-related numeracy skills (i.e. quantitative proficiency on the management of diabetes, including glucose meter readings, calculating carbohydrate intake and medication dosages) are associated with worse perceived self-efficacy, fewer self-management behaviors, and possibly poorer glycemic control [30]. Thus, diabetes self-management education programs are considered an essential strategy for improving health behaviors of adults with diabetes. In a study to estimate the impact of participation in a diabetes health education program on glycemic and lipid levels, Roblin et al. reported that such participation significantly improved glycemic and lipid levels between baseline and follow-up periods [31]. In contrast, participation in a diabetes health education program was not associated with lower HbA_{1c} values in our survey. Our assessment was limited to whether the patient had ever participated in a diabetes health education program, and did not differentiate subjects according to the amount of time and/or effort dedicated to such programs. One may argue that patients attending a diabetes program once or a few times might not benefit from this education. This might have precluded our data to show the potential impact of diabetes education programs on the glycemic control of these patients.

Among patients with type 2 diabetes in our survey, self-perception of glycemic control was associated with HbA_{1c} levels; i.e., patients perceiving their glycemic control to be "poor" or "fair" were more likely to present higher HbA_{1c} values. This awareness may result from the patients experiencing adverse symptoms associated with hyperglycemia, the patients' knowledge about their actual adherence to diet and antidiabetic medication, and/or the patients' information of their recent HbA_{1c} results. Unsurprisingly, we also found that global satisfaction with current diabetes treatment was associated with improved glycemic control in type 2 diabetic patients. It has been shown that improvement in patient convenience provided better compliance with therapeutic regimen and greater patient satisfaction, and this in turn led to better glycemic control [32,33].

4.1. *Strengths and limitations*

The distinctive strengths of this study are the large multicenter sample, the data collection by trained and certified interviewers not part of the local center staff, the measurement of HbA_{1c} by a reliable method in a central laboratory, and the high response rate (92%). Despite that, one limitation is that the study was center based, and while our sample might be representative of patients with diabetes attending health care facilities in Venezuela, it may not be representative of the whole population of Venezuelan patients with diabetes. However, the prevalence of poor glycemic control among diabetic patients not attending a health care service might be even higher than among patients doing so, such as those in our survey. Therefore our estimate of inadequate glycemic control, although high, could actually be underestimated.

4.2. *Final comments*

Despite clinical evidence supporting tight control of diabetes, increased awareness of the benefits of improved metabolic control, and publication of target goals, we found that few diabetic patients in Venezuela met recommended glycemic control targets. This may contribute to increased rates of macrovascular and microvascular diabetic complications, which may impact health care costs. The reasons for a worse metabolic control in patients treated with insulin are not evident in our data. One may argue that poor adherence to insulin and/or some degree of inertia to apply the best currently available treatment regime in patients who need insulin might account for this finding. Our data support the public health message of implementation of early, aggressive management of diabetes.

Conflict of interest

Edson D. Moreira Jr. is a consultant for Pfizer Inc.; Raimundo C.S. Neves has no conflicts of interest; Zaira O. Nunes has no conflicts of interest; Maria C.C. de Almeida has no conflicts of interest; Ana B.V. Mendes is an employee of Pfizer Inc. (at the time the study was conducted); João A.S. Fittipaldi is an employee and stock owner of Pfizer Inc.; Franklin Ablan has no conflicts of interest.

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REFERENCES

[1] S. Wild, G. Roglic, A. Green, R. Sicree, H. King, Global prevalence of diabetes: estimates for the year 2000 and projections for 2030, Diabetes Care 27 (2004) 1047–1053.
[2] D. Yach, D. Stuckler, K.D. Brownell, Epidemiologic and economic consequences of the global epidemics of obesity and diabetes, Nat. Med. 12 (2006) 62–66.
[3] K.M. Narayan, E.W. Gregg, A. Fagot-Campagna, M.M. Engelgau, F. Vinicor, Diabetes—a common, growing, serious, costly, and potentially preventable public health problem, Diabetes Res. Clin. Pract. 50 (Suppl. 2) (2000) S77–84.
[4] The Diabetes Control and Complications Trial Research Group, The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus, N. Engl. J. Med. 329 (1993) 977–986.
[5] UK Prospective Diabetes Study (UKPDS) Group, Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33), Lancet 352 (1998) 837–853.
[6] Writing Team for the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group. Effect of intensive therapy on the microvascular complications of type 1 diabetes mellitus, JAMA 287 (2002), 2563–2569.
[7] American Association of Clinical Endocrinologists, American College of Endocrinology consensus statement on guidelines for glycemic control, Endocr. Pract. 8 (2002) 5–11.
[8] S.H. Saydah, J. Fradkin, C.C. Cowie, Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes, JAMA 291 (2004) 335–342.
[9] N.C. Yu, H.Y. Su, S.T. Tsai, B.J. Lin, R.S. Shiu, Y.C. Hsieh, et al., ABC control of diabetes: survey data from National Diabetes Health Promotion Centers in Taiwan, Diabetes Res. Clin. Pract. (2009).
[10] M. Kobayashi, K. Yamazaki, K. Hirao, M. Oishi, A. Kanatsuka, M. Yamauchi, et al., The status of diabetes control and antidiabetic drug therapy in Japan—a cross-sectional survey of 17,000 patients with diabetes mellitus (JDDM 1), Diabetes Res. Clin. Pract. 73 (2006) 198–204.
[11] K.M. Fox, R.A. Gerber Pharmd, B. Bolinder, J. Chen, S. Kumar, Prevalence of inadequate glycemic control among patients with type 2 diabetes in the United Kingdom general practice research database: a series of retrospective analyses of data from 1998 through 2002, Clin. Ther. 28 (2006) 388–395.
[12] D. Pittrow, G.K. Stalla, A.M. Zeiher, S. Silber, W. Marz, L. Pieper, et al., Prevalence, drug treatment and metabolic control of diabetes mellitus in primary care, Med. Klin. (Munich) 101 (2006) 635–644.
[13] L.G. Jorgensen, P.H. Petersen, L. Heickendorff, H.J. Moller, J. Hendel, C. Christensen, et al., Glycemic control in diabetes in three Danish counties, Clin. Chem. Lab. Med. 43 (2005) 1366–1372.
[14] C.F. Otieno, M. Kariuki, L. Ng'ang'a, Quality of glycaemic control in ambulatory diabetics at the out-patient clinic of Kenyatta National Hospital, Nairobi, East Afr. Med. J. 80 (2003) 406–410.
[15] A. Ben Abdelaziz, I. Soltane, K. Gaha, H. Thabet, H. Tlili, H. Ghannem, Predictive factors of glycemic control in patients with type 2 diabetes mellitus in primary health care, Rev. Epidemiol. Sante Publique 54 (2006) 443–452.
[16] S.B. Harris, J.M. Ekoe, Y. Zdanowicz, S. Webster-Bogaert, Glycemic control and morbidity in the Canadian primary care setting (results of the diabetes in Canada evaluation study), Diabetes Res. Clin. Pract. 70 (2005) 90–97.
[17] G. Lopez Stewart, M. Tambascia, J. Rosas Guzmán, F. Etchegoyen, J. Ortega Carrión, S. Artemenko, Control of type 2 diabetes mellitus among general practitioners in private practice in nine countries of Latin America, Revista Panamericana de Salud Pública 22 (2007) 12–20.
[18] American Diabetes Association. Standards of medical care for patients with diabetes mellitus, Diabetes Care, 26 (Suppl. 1) (2003) S33–S50.
[19] K. Arai, K. Hirao, I. Matsuba, M. Takai, K. Matoba, H. Takeda, et al., The status of glycemic control by general practitioners and specialists for diabetes in Japan: a cross-sectional survey of 15,652 patients with diabetes mellitus, Diabetes Res. Clin. Pract. 83 (2009) 397–401.
[20] A.N. Goudswaard, R.P. Stolk, P. Zuithoff, G.E. Rutten, Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care, Eur. J. Epidemiol. 19 (2004) 541–545.

[21] T.J. Hoerger, J.E. Segel, E.W. Gregg, J.B. Saaddine, Is glycemic control improving in U.S. adults? Diabetes Care 31 (2008) 81–86.
[22] B.R. Shah, J.E. Hux, A. Laupacis, B.Z. Mdcm, P.C. Austin, C. van Walraven, Diabetic patients with prior specialist care have better glycaemic control than those with prior primary care, J. Eval. Clin. Pract. 11 (2005) 568–575.
[23] A.B.V. Mendes, J.A.S. Fittipaldi, R.C.S. Neves, A.R. Chacra, E.D. Moreira Jr., Prevalence and correlates of inadequate glycaemic control: results from a nationwide survey in 6,671 adults with diabetes in Brazil, Acta Diabetol. (August) (2009) (Epub ahead of print).
[24] K. Hawthorne, S. Tomlinson, Pakistani Moslems with Type 2 diabetes mellitus: effect of sex, literacy skills, known diabetic complications and place of care on diabetic knowledge, reported self-monitoring management and glycaemic control, Diabet. Med. 16 (1999) 591–597.
[25] A.L. Salcedo-Rocha, J.E. Garcia de Alba-Garcia, M.J. Frayre-Torres, B. Lopez-Coutino, Gender and metabolic control of type 2 diabetes among primary care patients, Rev. Med. Inst. Mex Seguro Soc. 46 (2008) 73–81.
[26] G. De Berardis, F. Pellegrini, M. Franciosi, M. Belfiglio, B. Di Nardo, S. Greenfield, et al., Quality of care and outcomes in type 2 diabetic patients: a comparison between general practice and diabetes clinics, Diabetes Care 27 (2004) 398–406.
[27] A.G. Tabak, G. Tamas, J. Zgibor, R. Wilson, D. Becker, Z. Kerenyi, et al., Targets and reality: a comparison of health care indicators in the U.S. (Pittsburgh Epidemiology of Diabetes Complications Study) and Hungary (DiabCare Hungary), Diabetes Care 23 (2000) 1284–1289.
[28] M.C. Leinung, A.G. Gianoukakis, D.W. Lee, S.L. Jeronis, J. Desemone, Comparison of diabetes care provided by an endocrinology clinic and a primary-care clinic, Endocr. Pract. 6 (2000) 361–366.
[29] J.C. Zgibor, T.J. Songer, S.F. Kelsey, J. Weissfeld, A.L. Drash, D. Becker, et al., The association of diabetes specialist care with health care practices and glycemic control in patients with type 1 diabetes: a cross-sectional analysis from the Pittsburgh epidemiology of diabetes complications study, Diabetes Care 23 (2000) 472–476.
[30] K. Cavanaugh, M.M. Huizinga, K.A. Wallston, T. Gebretsadik, A. Shintani, D. Davis, et al., Association of numeracy and diabetes control, Ann. Intern. Med. 148 (2008) 737–746.
[31] D.W. Roblin, E. Ntekop, E.R. Becker, Improved intermediate clinical outcomes from participation in a diabetes health education program, J. Ambul. Care Manage. 30 (2007) 64–73.
[32] H. Ishii, J.H. Anderson Jr., A. Yamamura, M. Takeuchi, I. Ikeda, Improvement of glycemic control and quality-of-life by insulin lispro therapy: assessing benefits by ITR-QOL questionnaires, Diabetes Res. Clin. Pract. 81 (2008) 169–178.
[33] J. Rosenstock, J.C. Cappelleri, B. Bolinder, R.A. Gerber, Patient satisfaction and glycemic control after 1 year with inhaled insulin (Exubera) in patients with type 1 or type 2 diabetes, Diabetes Care 27 (2004) 1318–1323.