Achievement of National Clinical Practice Recommendations among those in the Puerto Rican Population with Diabetes Mellitus

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Objective: To analyze glycemic control among patients with diabetes mellitus (DM) in Puerto Rico (PR) using the 2011 American Diabetes Association (ADA) recommendations and glycemic goals as standards. We also explored other factors that are related to glycemic control.

Methods: Glycemic data were obtained from 600 adults with DM from 5 different regions in PR. The patient's health insurance coverage, type of health care provider, type of diabetes treatment, gender, age, physical activity, weight, degree of hypertension and degree and type of dyslipidemia comorbidities (when one or both were applicable), and disease duration were variables of interest. Univariate and bivariate analyses were conducted to describe the population and determine the statistical differences in the glycemic control of the subjects.

Results: Fewer than half of the participants achieved the ADA-recommended levels for HbA1c (37.3%) and blood pressure (34%). However, relatively more participants met the goals for high-density lipoprotein cholesterol (51.7%), low-density lipoprotein cholesterol (59.9%), and triglycerides (61.5%). The percentage of participants reaching the HbA1c, blood pressure, and low-density lipoprotein cholesterol goals at the same time was 9.9%. Patients with private health insurance achieved better glycemic control than did patients in the public-managed healthcare system. Half of the population presented simultaneous hypertension, dyslipidemia, and DM comorbidities. Only 50% of the participants were physically active.

Conclusion: In the sample population, glycemic control levels and blood pressure levels in adults with DM were far from the ADA-recommended standards. Physical activity levels, type of medical insurance, and type of DM medical treatment were the main modifiable factors associated with the goal of attaining glycemic control. Barriers that limit the achievement of this goal should be analyzed in more detail to improve the medical care for people with DM. [*P R Health Sci J 2014;33:157-162*]

Key words: Puerto Rico, Diabetes, Glycemic control, HbA1c levels, Health insurance type

Diabetes mellitus (DM) is a chronic disease that disproportionally affects Hispanics (1). Puerto Rico (PR) has the highest prevalence of diabetes in the United States (US), including as well the other territories and Washington, DC (2). In 2010, approximately 13 of every 100 adults in PR self-reported having a diagnosis of diabetes (1). In addition, for the past 15 years, DM has been the third leading cause of death in PR.

Poor glycemic control has been associated with microvascular and macrovascular complications in people with diabetes (3-7). The American Diabetes Association (ADA) recommends lowering glycated hemoglobin (HbA1c) levels to below 7.0% to reduce the microvascular, macrovascular, and neuropathic complications of diabetes (8). The ADA further recommends reducing LDL - C levels to below 100 mg/dL. Data from the National Health and Nutrition Examination Survey (NHANES) revealed that glycemic control improved from 1999 through 2006 in the US (9). According to NHANES data, the age-adjusted percentages of people with diabetes diagnoses achieving the glycemic and low-density lipoprotein cholesterol (LDL-C) targets increased significantly from 43.1% to 57.1% and from 36.1% to 46.5%, respectively (10). However,

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the age-adjusted percentage of people achieving all the ADA recommended targets increased from 7.0% to 12.2%. A recent study in the metropolitan area of San Juan demonstrated that only 28.7% of the participants had HbA1c levels below 7.0%, and merely 6.6% of adults achieved all of the ADA goals for these 3 targets (11). However, this previous study did not include any other regions of PR, most of which have greater prevalences of diabetes and less access to health services.

The purpose of this study was to analyze glycemic control among adults with diabetes in PR using 2011 ADA recommendations and glycemic goals as standards. In addition, the concomitant comorbidities of hypertension and dyslipidemia were assessed. The study also explored other factors that could be related to glycemic control.

Research design and Methods

The estimated number of patients with diabetes (according to data published by the Centers for Disease Control and Prevention) was taken as the population basis for the study design. The main island of PR was divided into the 5 following regions: the metropolitan area of San Juan, the east, the north (not including San Juan), the west, and the south. The total number of diabetic patients per region was estimated from the BRFSS sample for 2010. The study sample size was calculated using OpenEpi version 3.01. Based on the Census 2010 data and the Puerto Rico Department of Health's reported diabetes prevalence, the estimated number of adults with diabetes was 346,927. After setting the estimated population, the confidence level (1-α) at 95%, and the frequency of outcome factor at 50%, the OpenEpi output indicated a minimum sample size of 384 to detect statistically significant estimates for the variables of interest. We estimated that 600 patients could provide results with sufficient statistical power to show general trends in the complete population. Our study exceeded the minimum required sample size. The selection of the 600 patients took 12 months. We conducted 11 surveys/interviews around PR; blood samples were collected from and diabetes education provided to participants. Only patients over the age of 18 were selected. The criteria for exclusion included being pregnant, currently participating in a research protocol, having an infectious disease, having a tendency to bleed excessively or using steroids. The patients had to have a history of medically treated diabetes to be eligible for the study. The patients were invited to participate in the research through the media (written press, radio, and television). The study was approved by the Western Institutional Review Boards and registered with the FDA (number NCT01117831). All patients signed an informed consent form before participating in the study. Patients who were not old enough to provide legal consent (under the age of 21 and not legally emancipated) had to acquire the signature of a legal guardian. The protocol was explained to each patient and all questions were answered.

All patients were scheduled for an 8-hour fast, which was evaluated at a pre-determined local facility (clinic) at which demographic information, vital signs, and blood samples were taken and educational information given. The patients were asked to bring their medications or write down the names of those medications on paper. The demographic information and the results of all conducted tests were entered into a protected computerized system. Specially trained personnel were in charge of drawing blood. The same laboratory was used for blood test analyses, and the same electronic equipment was used to measure vital signs. After a given patient had been seated for 10 minutes, blood pressure was taken with professional equipment (OMRON Digital Blood Pressure Monitor [HEM-907XL]). Next, the patient was directed to stand and his or her weight and height were measured using a digital scale (Detecto ProDoc PD300) with that patient being barefoot and wearing street clothes. Body mass index was calculated electronically. The following formula was used to calculate BMI: Body weight (kgs) ÷ height in square meters. Patients were considered overweight if they had a BMI of from 25 to 29.9 kg/m^2, and obese if they had a BMI over 30 kg/m^2.

The following information was recorded during the patient interview: name, age, birth date, telephone number, duration of disease, history of high blood pressure and dyslipidemia, levels of physical activity (as reported by each patient), type of health provider, type of health insurance, and medications taken. Physical activity was reported by the patient as occurring never, daily, every other day, or weekly. The following tests were obtained while fasting: HbA1c, lipid profile, and serum creatinine. LDL-C was measured electronically using the Friedewald formula. The levels of non–high-density lipoprotein (HDL) cholesterol and an estimate of glomerular filtration per minute were calculated.

For purposes of the study, patients with an HbA1c greater than or equal to 7.0%, a systolic blood pressure greater than or equal to 130 mmHg, an LDL cholesterol level greater than or equal to 100 mg/dL, triglycerides greater than or equal to 150 mg/dL, and a non-HDL cholesterol level greater than or equal to 130 mg/dL were considered outside the treatment goal (9). The parameters established by the National Kidney Foundation, Inc., were used to categorize renal function. A given patient's self-reported diagnosis of having high blood pressure diagnoses and – when applicable - a list of his or her current medications were accepted as being part of the patient's medical history. Either a self-reported diagnosis or a list of medications being taken to treat dyslipidemia was accepted to establish that patient's having a self - reported diagnosis of dyslipidemia. Patients had to have a history of medically treated diabetes to be eligible for the study.

Frequency distributions were computed to describe the demographic and health service usage characteristics of the participants. Bivariate analyses using contingency tables and

Pearson's chi-squared test and independent samples t-tests were conducted to determine whether there were significant differences between adults with diabetes with HbA1c levels of less than 7.0% and those with HbA1c levels of 7.0% or more in terms of demographics, health service usage characteristics, and comorbidities. For statistical analyses, alpha was set at $p<0.05$. Analyses were performed using Statistical Package for Social Scientists (SPSS) version 12.0 (IBM-SPSS, Chicago, IL).

Results

The analyzed data included information on 600 adults with diabetes residing in PR. Table 1 displays the characteristics of the patients. Most participants were 45 years old or older (92.5%), had health insurance (95.8%), had been diagnosed with diabetes for 5 or more years (71.6%), had a general practitioner or internist as their primary care physician (76.4%), and were using only oral medication to treat their diabetes (64.5%); a small majority (57.3%) was female. In addition, 49.8% of the patients were not physically active, and 85.0% were either overweight or obese.

Hypertension and dyslipidemia were highly prevalent in the subjects. Upon evaluating morbidities independently, 72.2% of the participants had high blood pressure and 61.5% had dyslipidemia. Moreover, 49.8% had both hypertension and dyslipidemia as comorbidities.

Table 2 presents the proportion of adults meeting selected ADA clinical practice recommendations for the prevention of DM-related complications. The mean value of HbA1c in the sample was 8.1% (standard deviation ± 1.9%). Only 37.3% of the adults with DM achieved the HbA1c goals, and only 34.0% had normal blood pressure. However, over half of the participants met the goals for HDL-C (51.7%), LDL-C (59.9%), triglycerides (61.5%), and serum creatinine (90.8%). In addition, 79.8% of the participants had glomerular filtration rates greater than or equal to 60 mL/min/1.73m^2 (data not shown). The percentage of adults achieving appropriate HbA1c, blood pressure, and LDL-C levels at the same time was only 9.9%, whereas the percentage achieving all goals for HbA1c, blood pressure, LDL-C, HDL-C, triglycerides, and serum creatinine was 3.3%.

Table 3 compares the characteristics of participants by glycemic control. These bivariate analyses revealed that a higher proportion of adults with poor glycemic control (HbA1c ≥ 7.0%) were younger (mean age 61.1 vs. 64.8 years; $p<0.01$), were diagnosed with DM at a younger age (48.8 vs. 56.4; $p<0.01$), were obese (51.9% vs. 43.8%), were not physically active (54.3% vs. 42.3%; $p<0.01$)), had diagnosed DM for 5 years or longer (79.4% vs. 58.4%; $p<0.01$), were using a dual therapy of oral medication and insulin (26.1% vs. 7.1%; $p<0.01$), had public insurance (14.0% vs. 6.8%; $p<0.01$), and had as a primary care physician a general practitioner or internist (78.7% vs. 77.6%; $p<0.01$). However, significant differences by glycemic control were only observed in age, age at DM diagnosis, physical activity, duration of DM, type of DM treatment, and type of insurance ($p<0.05$).

Table 1. Demographics, comorbidities, and health services that are characteristics of adults in PR with diabetes

Variable	Mean	SD
Age (years)	62.5	± 11.9
Age at DM diagnosis (years)	51.6	± 12.8
	Number	**Percent (%)**
Age distribution (%)		
18-24	45	7.5
45-64	281	46.8
≥65	274	45.7
Sex		
Male	256	42.7
Female	344	57.3
BMI (Kg/m^2)		
<25.0	90	15.0
25-29.9	217	36.2
≥30	293	48.8
Physical activity		
Daily	222	37.3
Every other day	77	12.9
Never	297	49.8
Duration with diabetes (years)		
<5	167	28.4
5-14	250	42.5
≥15	171	29.1
Type of treatment		
Oral treatment only	387	64.5
Insulin treatment only	70	11.7
Insulin and oral treatment	114	19.0
None	29	4.8
Comorbidities		
Hypertension	134	22.3
Dyslipidemia	70	11.7
Hypertension and dyslipidemia	299	49.8
Only diabetes	97	16.2
Type of health insurance		
Managed care	67	11.3
Private (fee for service and Medicare)	502	84.5
None	25	4.2
Type of provider		
General practitioner	248	42
Internist	176	30
Family physician	29	5
Endocrinologist	89	15
Cardiologist	38	6
Not determined	14	2
Geographic area*		
Metropolitan area	331	55
East	63	10
Ponce (south)	87	16
Mayaguez (west)	75	12
Arecibo (north)	40	7

*Does not represent patients' area of residence because some of them visited clinics outside those geographic areas.

Table 2. Proportion of adults with DM achieving selected ADA recommendations for preventing diabetes complications (n=600).

Recommendation	Number	Percentage (%)
HbA1c <7.0%	224	37.3
Blood pressure <130/80 mm Hg	204	34.0
Triglycerides <150 mg/dL	369	61.5
*LDL-C <100 mg/dL	346	59.9
HDL-C ≥40 mg/dL in men and ≥50 mg/dL in women	310	51.7
Serum creatinine 0.5-1.5 mg/dL in men and 0.6-1.2 mg/dL in women	545	90.8
*HbA1c + blood pressure + LDL-C target goals	57	9.9
*HbA1c + blood pressure + LDL-C + HDL-C + Triglycerides + serum creatinine target goals	19	3.3

*Based on 578 participants (22 subjects had serum triglycerides over 400 mg/dL and these were removed from the analysis as LDL calculations are not valid when serum triglycerides level is over 400 mg/dL) (14). ADA, American Diabetes Association; HbA1c, glycated hemoglobin; DM, diabetes mellitus; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol (12).

Discussion

In this study, we observed differences in the glycemic control of adults with diabetes in PR compared to such control in this population in the US. These differences included glycemic control as well as the achievement of blood pressure goals and improved LDL-C levels. The percentage of patients with glycated hemoglobin levels less than 7%, LDL-C levels of less than 100 mg/dL, and blood pressure lower than 130/80 mm Hg was 9.9%. These results are similar to those reported by Pérez and colleagues in a representative sample of the metropolitan area, which report showed that fewer than 10% of adults with diabetes in this area reached the goals established by the ADA (11).

The percentage of patients with glycemic control (37%) in this study is considerably lower than the percentage reported for the years of 2003 to 2006 (57%) in the US (8). Poor compliance with glycemic control was observed in all health insurance plans patients analyzed. However, the greatest differences were observed in those patients covered by the health insurance provided by the PR government (Health Reform), which is offered by the same insurance companies as those of other plans (including private plan and Medicare Advantage plan. We observed no significant differences in the management by different health service providers; however, the type of medication used by patients who subscribed to different health insurance plans differed. In addition, the majority of patients with poor glycemic control were using only 1 type of oral treatment for glycemic control. As expected, patients who had the condition for shorter periods of time had better control than did patients who had had the disease for longer periods of time. This can be explained by the degeneration of β-cells that produce insulin (secondary failure).

Table 3. Glycemic control by demographics, comorbidities, and health services that are characteristics of adults with diabetes in PR

Variable	HbA1c <7.0% (n = 224)	HbA1c ≥7.0% (n = 376)	p value
Age (mean and SD)	64.8±11.1 years	61.1±12.1 years	< 0.01*
Age at DM diagnosis (mean and SD)	56.4±12.5 years	48.8±12.1 years	< 0.01*
Variable	**HbA1c < 7.0% (n = 224)**	**HbA1c ≥ 7.0% (n = 376)**	**p value**
Age distribution (%)			
18-44 years	5.8	8.5	
45-64 years	39.3	51.3	< 0.01*
≥65 years	54.9	40.2	
Sex (%)			
Male	40.2	44.1	0.34
Female	59.8	55.9	
BMI (%)			
<25.0	16.9	13.8	
25.0-29.9	39.3	34.3	0.15
≥30	43.8	51.9	
Physical activity (%)			
Daily	40.1	35.6	
Every other day	17.6	10.2	<0.01*
Never	42.3	54.3	
Duration of DM (%)			
<5 years	41.6	20.6	
5-14 years	39.7	44.2	<0.01*
≥15 years	18.7	35.2	
Type of DM treatment (%)			
Oral treatment only	81.3	54.5	
Insulin treatment only	3.6	16.5	<0.01*
Insulin and oral treatment	7.1	26.1	
None	8.0	2.9	
Comorbidities (%)			
Hypertension	25.0	20.7	
Dyslipidemia	10.3	12.5	0.61
Hypertension and dyslipidemia	48.7	50.5	
Diabetes only	16.1	16.2	
Insurance (%)			
Managed care	6.8	14.0	
Private (fee for service and Medicare)	88.7	82.0	0.03*
None	4.5	4.0	
Primary care physician (%)			
General practitioner	47.9%	48.1%	
Internist	29.7%	30.6%	0.52
Endocrinologist	17.4%	13.9%	
Cardiologist	5.0%	7.4%	

*p value < 0.05, statistically significant

High blood pressure or dyslipidemia does not affect glycemic control. However, it appears that physical activity is a determining factor in glycemic control. It is clear that physical activity may be a therapeutic tool in a variety of patients with, or at risk for, diabetes mellitus (13). Lifestyle interventions,

including ~150 min/week of physical activity and diet-induced weight loss of 5 to 7% of total body weight, reduce the risk of progression from impaired glucose tolerance (IGT) to diabetes mellitus by 58% (14).

For many years, exercise, diet and medication, have been considered the cornerstones of diabetes therapy. Physical activity improves glucose utilization by insulin-sensitive tissue, reduces glycemia, and decreases the risk of chronic complications (15). Regular physical activity is recommended for patients with diabetes mellitus because it may have beneficial effects on metabolic risk factors that lead to the development of diabetic complications. The low-cost and non-pharmacological nature of physical activity makes this intervention an ideal initial therapy for diabetic patients.

The average HbA1c of patients was 8.1%, indicating that this population is at greater risk for chronic complications related to diabetes. There is evidence that for each percentage point decrease in HbA1c, the risk of suffering from any of the chronic complications of diabetes significantly decreases. In the UK Prospective Diabetes Study (UKPDS), a significant reduction of 35% in diabetes microvascular complications was found for each A1C reduction of 1% (16–19). The UKPDS results confirm data from the DCCT(20), the Stockholm Diabetes Intervention Study (21), and a Japanese study (22) on the role of chronic hyperglycemia in the development of diabetes mellitus micro- and macrovascular complications.

This study examined the problem of poor glycemic control in diabetes patients in PR. However, it remains unclear why PR patients have such poor control, even though 95.8% of the participants had medical insurance coverage and access to medical services. This is the first study in PR describing glycemic control and its related factors in a population from different regions of the island. Because diabetes mellitus has the same burden as cardiovascular disease, the high prevalence of diabetes, as well as its poor control, may explain why diabetes is the third leading cause of death in PR.

There are some limitations inherent to our study methodology. First, participants were recruited using a non-probabilistic convenience sample, which can introduce systematic bias via the presence of sampling bias. To reduce this bias, samples were drawn from different regions of PR to increase the variability of the participants. However, the studied population was homogeneous in some characteristics that could affect our findings. Another limitation is that we did not consider other factors that may affect glycemic control, such as socioeconomic status or the presence of other morbidities.

In the future, it will be very important to study, in-depth, those factors that affect glycemic control, blood pressure, and lipid control in Puerto Rican adults with diabetes, including among them socio-demographic, nutritional, and cultural factors. Additionally, the types of treatment used for glycemic control in these patients should be examined further. Our data show that most patients with poor glycemic control are under only 1 treatment regimen. It would be interesting to determine why these patients have not begun insulin treatment, particularly in light of the fact that oral treatments are less effective. It is also important to identify health disparities in this population if health care equity is to be achieved.

Resumen

Objetivo: Analizar el control glucémico en la población diabética (DM) en Puerto Rico (PR) utilizando las guías de la Asociación Americana de Diabetes (ADA, por sus siglas en inglés). Además exploramos otros factores relacionados con el control glucémico. Métodos: Datos sobre el control glucémico en 5 regiones de PR fueron obtenidos en una muestra de 600 pacientes adultos con diabetes mellitus. Se analizaron las siguientes variables: seguro médico, proveedor, tratamiento, sexo, niveles de actividad física, peso, grado de hipertensión, grado y tipo de dislipidemia y duración de la enfermedad en la población analizada. Se realizó un análisis uni y bivariado para describir la población y determinar las diferencias estadísticas del control glucémico de los pacientes. Resultados: Menos de la mitad de los participantes logró el control glucémico recomendado por ADA para la HbA1c (37.7%), y la presión arterial (34%). Sin embargo, relativamente más participantes lograron las metas para el colesterol de alta densidad (51.7%), el colesterol de baja densidad (59.9%) y los triglicéridos (61.5%). El porcentaje de participantes que lograron las metas de HbA1c, de presión arterial y de colesterol de baja densidad a la misma vez fue de 9.9%. Los pacientes con un seguro médico privado lograron un mejor control glucémico que los pacientes bajo cuidado coordinado. La mitad de los participantes presentaron a la vez hipertensión, dislipidemia y diabetes mellitus. Solo la mitad de los participantes estaban físicamente activos. Conclusión: El control glucémico y de la presión arterial en los adultos con DM en la población analizada están lejos de los valores establecidos por la ADA. Los niveles de actividad física, el tipo de seguro médico y el tipo de tratamiento son factores médicos modificables asociados con el control glucémico.

Abbreviations

ADA: American Diabetes Association; HbA1c: glycated hemoglobin; DM: Diabetes mellitus; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; PR: Puerto Rico; NHANES: National Health and Nutrition Examination Survey; CDC: Centers for Disease Control and Prevention; FDA: Food and Drug Administration; NKF: National Kidney Foundation; SPSS: Statistical Product and Service Solution; GFR: Glomerular filtration rate; UKPDS: United Kingdom Prospective Diabetes Study

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