Characteristics of Ketosis-Prone Diabetes in a Multiethnic Indigent Community

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Objective: To compare demographic and clinical characteristics among 3 ethnic groups of indigent patients exhibiting diabetic ketoacidosis (DKA), in Houston, Texas.

Methods: Over a span of 3.5 years, 321 patients were interviewed at the time of admission for DKA. Demographic, clinical, and biochemical data and measures of pancreatic β-cell function were obtained at baseline and during follow up. Pearson's chi-square test, or one-way ANOVA, were used, as appropriate, to evaluate group differences.

Results: Of the 321 subjects, 44% were African-American, 40% were Hispanic, and 16% were Caucasian. A significantly higher proportion of Hispanics had preserved β-cell function, compared to African Americans and Caucasians (51% vs 32% and 32%, respectively; $P=.002$). This difference, present at the time of the admission, was maintained through follow up. In a multivariate analysis, Hispanic ethnicity (OR 3.61; 95% CI 1.48–9.29) was a significant predictor of preserved β-cell function. In addition, Hispanics were less likely to develop DKA as a result of treatment noncompliance, and more likely to have DKA precipitated by an acute illness.

Conclusions: Our findings indicated that ethnicity is associated with significant differences in the pathophysiologic and clinical characteristics of indigent, ketosis-prone patients. Hispanic ethnicity was found to be associated with greater β-cell functional reserve, and less dependence on chronic insulin therapy. (*Ethn Dis*. 2004;14:243–249.)

Key Words: African-American, β-cell function, Caucasian, Compliance, Diabetic Ketoacidosis, Ethnicity, Hispanic

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Introduction

Diabetic ketoacidosis (DKA), a serious, acute metabolic complication of diabetes mellitus,[1] is highly prevalent among indigent populations.[2–4] In the Ben Taub General Hospital (a tertiary care facility of Harris County Hospital District, the fourth largest public health system in the United States), DKA accounts for 15% of the hospital discharges among subjects with diabetes. Although previously considered a complication restricted primarily to patients with type 1 diabetes, DKA has been reported in recent years to occur in patients from various non-Caucasian ethnic groups who lack the typical characteristics of type 1 diabetes,[3,5–8] raising questions as to the role of ethnicity in DKA's etiology and natural history.

The annual incidence of DKA (estimated from population-based studies) ranges from 4.6 to 8 episodes per 1,000 patients with diabetes.[9–11] It is more common in younger patients.[11] Recent epidemiological studies in the United States estimate that hospitalizations for DKA have increased during the past 2 decades, especially among African Americans.[12] Further, DKA is the initial manifestation of diabetes in 20%-30% of these patients.[11] Currently, DKA is listed as a diagnosis in 4%–9% of all hospital discharge summaries among adult patients with diabetes.[2]

There is a perception that ethnicity confers distinct characteristics on the incidence, prevalence, and even pathophysiology of type 2 diabetes. For example, the prevalence of type 2 diabetes is known to be approximately 2–4 times higher in Hispanics, and 2.5–3 times higher in African Americans, compared to Caucasians.[13] In recent years, the prevalence of type 2 diabetes among Hispanics in the United States has increased by 37%, compared to a 26% increase among African Americans.[13,14] The ethnic frequencies and ethnic-specific pathophysiologic characteristics of ketosis-prone diabetes are unknown. In the present study, we hypothesized that demographic, clinical, and biochemical differences exist between ketosis-prone Hispanic, African-American, and Caucasian diabetic patients, and that these differences predict clinical outcomes, after resolution of an acute episode of ketoacidosis.

Methods

Patient identification

Three hundred twenty-one consecutive adult patients admitted with DKA to Ben Taub General Hospital (BTGH, Houston, Tex), from June 1, 1999 to November 30, 2002, were interviewed during the hospital admission. Diabetic ketoacidosis (DKA) was defined by the following parameters: 1) serum bicarbonate level <18 mEq/L; 2) anion gap >14; 3) blood pH <7.30; 4) serum glucose >250 mg/dL; 5) documented presence of serum or urine ketones; 6) absence of concomitant conditions that might result in anion gap acidosis or, ketosis, such as pregnancy, renal insufficiency (other than a mild, reversible, "pre-renal" state), lactic acidosis, acute alcohol intoxication, or organic poison ingestion. After informed consent was obtained, information was obtained from each patient regarding demographic characteristics, clinical features, and factors precipitating the DKA episode.

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Measures

Demographic variables included age, gender, education level, and employment status. Ethnicity was determined by patient self-identification as African-American (AA), Hispanic (H), or Caucasian (C). Age was categorized in 2 intervals: 16 to 34 years, and 35 years or older; the 35-years-old cut off was used because this age has been utilized in the past to distinguish type 1 from type 2 persons with diabetes.[15] Education level was categorized as 2 groups: those who had graduated from high school, and those who had not. Employment status was categorized as 2 groups: those who were employed at the time of hospital admission, and those who were not. The following clinical characteristics were recorded: family history of diabetes, height, weight, body mass index (BMI), and duration of known diabetes. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (in meters). Obesity was defined as BMI $\geq$30 kg/m^2. Based on a review of the medical records, and the interview with each subject, the factors precipitating the DKA episode were divided into 3 categories: 1) non-compliance with diabetes treatment (in which the patient inappropriately discontinued the pre-DKA diabetes treatment); 2) acute illness (in which any acute illness precipitated the DKA episode in a patient who continued with the pre-DKA diabetes treatment); and 3) "new onset" diabetes (in which patients were unaware of having diabetes and no specific precipitating factor was identified).

The following laboratory values were obtained: initial serum glucose level at admission; HbA_{1c} at admission; C-peptide concentration was measured during a steady-state condition, with a fasting serum sample being obtained 24 hours after complete correction of ketoacidosis, and when intravenous infusions had been discontinued for at least 8 hours. Based on the fasting serum C-peptide level, patients were categorized as having preserved β-cell function if the C-peptide level was $\geq$1 ng/dL (0.33 nmol/L), or absent β-cell function if the C-peptide level was $<$1 ng/dL. This serum C-peptide level is a widely accepted cut-off value to differentiate subjects with preserved β-cell functional reserve from those with complete β-cell failure.[16,17] We also validated this measure by comparing fasting serum C-peptide concentrations with areas under the curve for C-peptide response to glucagon stimulation using Receiver Operator Curve analysis.[8] Absent β-cell insulin secretory reserve as defined by the above criterion is a key pathophysiologic determinant of susceptibility to recurrent ketoacidosis and dependence on insulin treatment.[1,18] We used the following formula to calculate the C-peptide to glucose ratio: [C-peptide (ng/dL)/serum glucose (mg/dL)] $\times$ 100.[19] C-peptide concentrations were determined by highly specific radioimmunoassay in our research laboratory, using a human C-peptide RIA kit (Linco Research Inc, St. Louis, Mo).

The patients were followed in the outpatient clinics of Ben Taub General Hospital, and were encouraged to attend an assigned clinic at least every 2 months, or more frequently if the clinical situation required it. Telephone calls from the study nurse reminded the patients of their follow-up clinic appointments. The mean follow-up duration for this study was 740 $\pm$ 231 days. Patients who did not attend their assigned clinic for 3 or more consecutive months were excluded from the analysis. The number of re-admissions for DKA, the number of clinic visits, and the anti-diabetic medications being taken were recorded. HbA_{1c} was measured every 3 months, and steady-state fasting serum C-peptide and glucose levels (to calculate the C-peptide to glucose ratio and the proportion of subjects with preserved β-cell function) were measured 3, 6, and 12 months after the index episode of DKA. The last value measured was used for the comparisons between the 3 ethnic groups.

Analysis

Data analyses were performed using the JMP 5.0 statistical package (SAS Institute Inc., 2002). Statistical tests of patient demographic, clinical, and biochemical data were analyzed using *t* tests, ANOVA, and chi-square tests. *P* values were calculated using the likelihood ratios method. Pair-wise testing with a post-hoc multiple comparison procedure (Tukey-Kramer) was used when the 3-group comparison indicated significant group differences. Descriptive values are presented as means $\pm$ standard deviation. Results were considered statistically significant at $P<.05$. To determine predictive factors for non-compliance as a precipitant of DKA, we performed a nominal multiple regression analysis calculating the odds ratios (OR 95% CI). The characteristics included in the analysis were those in which we found significant differences in a univariate analysis, comparing subjects based on the precipitating cause of the DKA episode (non-compliance compared to acute illness). We excluded patients with new-onset diabetes from this analysis because these subjects were, by definition, unaware that they had diabetes; therefore, compliance with diabetic therapy was not an issue. To determine predictive factors for preserved β-cell function (fasting serum C-peptide concentration $\geq$1 ng/dL), we performed a nominal multiple regression analysis calculating the odds ratios and

Table 1. Demographic and clinical characteristics of 321 subjects with DKA (univariate analysis)

	African American	Hispanic	Caucasian	*P* value
Number of subjects*	143 (44%)	128 (40%)	50 (16%)	—
Age†	41 ± 14	37 ± 14	39 ± 12	.04[a]
Age <35 years	49 (34%)	67 (52%)	17 (34%)	.005[b]
Male : female ratio	1.5:1	1.1:1	1.5:1	.5
High school graduate	75 (52%)	47 (37%)	32 (64%)	.001[b]
Employed	44 (31%)	63 (49%)	16 (32%)	.005[b]
Family history of DM	96 (72%)	84 (69%)	33 (69%)	.9
BMI ≥30 kg/m^2	39 (27%)	34 (27%)	9 (18%)	.4
Age at diagnosis of DM†	34 ± 14	31 ± 14	30 ± 15	.1
Years with DM†	6.9 ± 8.6	5.3 ± 6.7	8.7 ± 9.1	.03[c]
Insulin treatment pre-DKA‡	94 (90%)	66 (71%)	33 (87%)	.001[b]
Precipitant of DKA§				.01[a]
Non-compliance	87 (61%)	57 (45%)	29 (58%)	
Acute illness	17 (12%)	36 (28%)	9 (18%)	
New onset DM	39 (27%)	35 (27%)	12 (24%)	
Serum glucose at admission (mg/dL)	535 ± 192	461 ± 146	523 ± 220	.003[a]
HbA_{1c} at admission (%)†	13.8 ± 2.5	13.2 ± 2.2	12.8 ± 2.3	.02[d]
Fasting serum C-peptide (ng/dL)†	0.8 ± 1.3	1.1 ± 1.0	0.7 ± 0.9	.02[a]
C-peptide to glucose ratio (ng/mg × 100)	0.35 ± 0.47	0.58 ± 0.45	0.42 ± 0.56	.002[a]
Preserved β-cell function	45 (32%)	65 (51%)	16 (32%)	.002[b]

* Row percent.
† Mean with standard deviation.
‡ Subjects with new-onset diabetes were excluded.
§ Column percent.
[a] Significant difference in the pair-wise comparison of Hispanic vs African American.
[b] Significant differences in the following pair-wise comparisons: Hispanic vs African American and Hispanic vs Caucasian.
[c] Significant differences in the following pair-wise comparisons: Hispanic vs Caucasian.
[d] Significant differences in the following pair-wise comparisons: African American vs Caucasian.

95% confidence intervals (OR 95% CI). The characteristics included in this analysis were those for which we found significant differences in a univariate analysis comparing subjects based on the C-peptide level (≥1 ng/dL vs <1 ng/dL).

RESULTS

During the study period, 321 patients were admitted with DKA (Table 1). The study sample included African Americans (AA) (44%), Hispanics (H) (40%), and Caucasians (C) (16%). The mean age at diagnosis was significantly different between Hispanics and the other 2 ethnic groups. A greater proportion of H patients were younger (52% <35 years), compared to AA patients (34%), and C patients (34%) (*P*=.005). The H group had a lower proportion of high school graduates (37%) compared to 52% and 64%, respectively, for the AA and C groups (*P*=.001). The converse was true for employment status, with 49% of H patients reporting current employment, compared to 31% of AA patients, and 32% of C patients (*P*=.005). The duration of diabetes was significantly lower in the H group, compared to the C group (*P*=.03). There were no differences between the ethnic groups in gender ratio, family history of diabetes, BMI, or age at diagnosis with diabetes.

The proportions of subjects admitted for DKA associated with new-onset diabetes were very similar among the 3 ethnic groups: 24%–27%. However, ethnic differences were observed in the other precipitating factors associated with developing DKA. Only 45% of the H patients were admitted with DKA secondary to non-compliance with the prescribed treatment for diabetes, compared to 61% in the AA group, and 58% in the C group (*P*=.01). Hispanic patients were more likely to be admitted for DKA secondary to an acute illness (28%), compared to AA patients (12%), and C patients (18%) (*P*=.01).

The mean serum glucose level at the time of admission for the index episode of DKA was higher in the AA group (535 mg/dL ± 192 mg/dL), compared to the H and C groups (461 mg/dL ± 146 mg/dL, and 523 mg/dL ± 220 mg/dL, respectively; *P*=.003). The HbA_{1c} level at the time of the admission was higher in the AA group (13.8 ± 2.5%), compared to the H and C groups (13.2 ± 2.2% and 12.8 ± 2.3%, respectively; *P*=.02). The mean fasting serum C-peptide concentration, after correction of ketoacidosis, was higher in the H group (1.1 ng/dL ± 1.0 ng/dL), compared to the AA and C groups (0.8 ng/

Table 2. Logistic regression analysis of predictors of non-compliance as precipitant of the DKA episode (*N*=235)*

Predictors	OR (95% CI)	*P* value
Age at diagnosis of DM <35 years	2.17 (1.05–4.67)	.04
Hispanic	0.38 (0.19–0.76)	.007
Unemployed	1.35 (0.67–2.69)	.4
High school graduate	0.61 (0.30–1.20)	.2
DM <6 months duration	0.23 (0.10–0.97)	.04
Insulin treatment before DKA	4.64 (2.10–10.42)	.0002

* Patients with ''new onset'' diabetes were excluded from this analysis. See text for details. The model included all the variables in the table.

dL ± 1.3 ng/dL, and 0.7 ng/dL ± 0.92 ng/d L, respectively; *P*=.02). The mean C-peptide to glucose ratio was significantly higher in the H group (0.58 ± 0.45), compared to the AA and C groups (0.35 ± 0.47 and 0.42 ± 0.56, respectively; *P*=.002). The proportion of patients with fasting serum C-peptide level=1 ng/dL (ie, with preserved β-cell function) was higher in the H group (51%), compared to the AA and C groups (32% for both; *P*=.002).

To further evaluate the clinical and demographic features associated with non-compliance as a precipitant of the index DKA episode, a logistic regression analysis was performed (Table 2). Factors associated with non-compliance were: age at diagnosis of diabetes <35 years, OR: 2.17, 95% CI: 1.05–4.67 (*P*=.04); and a history of treatment with insulin prior to the episode of DKA, OR: 4.64, 95% CI: 2.10–10.44 (*P*=.0002). The following conferred significantly lower odds of developing DKA, secondary to non-compliance: Hispanic ethnicity, OR: 0.38, 95% CI: 0.19–0.76 (*P*=.007); and duration of DM <6 months, OR: 0.32, 95% CI: 0.10–0.97 (*P*=.04). Employment status and education level were not significant predictive factors for non-compliance in the multivariate analysis.

In the logistic regression analysis of predictors of preserved β-cell function (C-peptide ≥1 ng/dL), after correction of ketoacidosis (Table 3), the significant predictors were: Hispanic ethnicity, OR: 3.61, 95% CI: 1.48–9.29 (*P*=.005); duration of known diabetes <6 months, OR: 4.80, 95% CI: 2.10–11.35 (*P*=.0002); and BMI ≥30, OR: 5.73, 95% CI: 2.71–12.22 (*P*<.0001).

During the follow-up period, 28 patients (9%) failed to keep clinic appointments. The remaining 293 patients (91%) attended the outpatient clinics for a mean duration of 740 ± 231 days (RANGE: 90–1277 days). The ethnic distribution of these 293 subjects was 43% AA, 42% H, and 15% C. There were no significant ethnic differences in the mean duration of follow-up, number of clinic visits, or types of medication used to treat diabetes. A significantly higher proportion of AA patients (27%) were re-admitted for DKA, compared to H patients (11%; *P*=.01) (Table 4). The mean HbA_{1c} level at the time of the last follow-up clinic visit was significantly higher in the AA group (10.9% ± 3.3%), compared to the H and C groups (9.4% ± 3.2%, and 9.4% ± 3.1%, respectively; *P*=.001). The mean C-peptide to glucose ratio at the time of the last clinic visit was also significantly higher in the H group (1.45 ng/dL ± 1.32 ng/dL), compared to the A and C groups (0.54 ng/dL ± 0.83 ng/dL, and 0.81 ng/dL ± 1.37 ng/dL, respectively; *P*<.00001). At 6 and 12 months of follow up, the H group had significantly greater β-cell functional reserve, compared to the AA and C groups, as assessed by the fasting serum C-peptide to glucose ratio (*P*=.02 and .01; Figure 1).

Table 3. Logistic regression of predictors of fasting serum C-peptide ≥1 ng/dL after correction of ketoacidosis (*N*=321)

Predictors	OR (95% CI)	*P* value
Age at diagnosis of DM <35 years	0.51 (0.45–1.08)	.09
Hispanics	3.61 (1.48–9.29)	.005
DM <6 months duration	4.80 (2.10–11.35)	.0002
BMI ≥30	5.73 (2.71–12.22)	<.0001
Treated with insulin only	0.31 (0.15–0.70)	.006
Non-compliance vs other precipitating factors	0.51 (0.21–1.17)	.1

DISCUSSION

The results of this study reveal several significant clinical and biochemical differences between Hispanics, African Americans, and Caucasians with ketosis-prone diabetes. Ketosis-prone Hispanics with diabetes had better preserved β-cell functional reserve, compared to ketosis-prone patients with diabetes belonging to the other 2 ethnic groups, as evidenced by their higher mean fasting serum C-peptide levels, higher C-peptide to glucose ratios, and greater likelihood of having a fasting serum C-peptide level ≥1 ng/dL. This difference was apparent immediately after recovery from ketoacidosis at the time of the index DKA episode, and was largely preserved upon prolonged follow up in the clinic (6–12 months after the DKA episode). The greater preservation of β-cell functional reserve is likely to confer a significant clinical advantage to Hispanic patients. Ketosis-prone African-American and Caucasian patients with diabetes had significantly lower β-cell functional reserve, as reflected in lower fast-

Table 4. Characteristics from 3 to 36 months of follow-up

	African Americans	Hispanics	Caucasians	*P* value
Last HbA_{1c} (%)*†	10.9 ± 3.3	9.4 ± 3.2	9.4 ± 3.1	.001[a]
Insulin discontinuation‡	15 (12%)	20 (17%)	5 (12%)	.4
Readmitted with DKA‡	34 (27%)	14 (11%)	9 (20%)	.01[b]
Last fasting C-peptide (ng/dL)*§	0.8 ± 1.09	1.8 ± 1.5	0.99 ± 1.5	<.0001[c]
Last C-peptide/glucose ratio (ng/mg × 100)*§	0.54 ± 0.83	1.45 ± 1.32	0.81 ± 1.37	<.0001[c]
Preserved β-cell function on follow-up§	32 (30%)	59 (63%)	11 (30%)	<.0001[c]

* Mean with standard deviation.

† HbA_{1c} levels were measured 3–36 months after the index DKA in 238 subjects: 107 (75%) African Americans, 94 (73%) Hispanics, and 37 (74%) Caucasians. The last measured value for each patient was used for the comparisons.

‡ Data for analysis 3–36 months after the index DKA was available in 293 subjects: 126 (43%) African Americans, 122 (42%) Hispanics, and 45 (15%) Caucasians.

§ Fasting C-peptide and glucose levels were measured 3–36 months after the index DKA in 238 subjects: 107 (75%) African Americans, 94 (73%) Hispanics, and 37 (74%) Caucasians. The last measured value for each patient was used for the comparisons.

[a] Significant difference in the pair-wise comparison of African Americans vs Hispanics and African Americans vs Caucasians.

[b] Significant differences in the following pair-wise comparisons: Hispanics vs African Americans.

[c] Significant differences in the following pair-wise comparisons: Hispanics vs African Americans and Hispanics vs Caucasians.

ing serum C-peptide levels and smaller proportions of subjects with fasting C-peptide level ≥1 ng/dL.

We also observed ethnic differences in compliance with treatment regimens for ketosis-prone diabetes. Hispanics were less likely than African Americans and Caucasians to develop DKA as a result of non-compliance with their prescribed diabetes treatment. The rate of non-compliance as a DKA precipitant was highest among the African-American patients, closely followed by the Caucasian patients. This difference in the rate of non-compliance as a precipitant of DKA does not necessarily reflect a difference in behavioral characteristics between the ethnic groups. However, a higher proportion of African-American and Caucasian subjects were treated with insulin before the index DKA, possibly reflecting a more difficult treatment regimen in these ethnic groups. Hispanics may have had difficulty understanding the treatment regimen due to language barriers. The extent to which language barriers were a cause of treatment non-compliance is unclear, since Hispanics had a lower frequency of non-compliance.

The higher frequency of preserved β-cell functional reserve among Hispanic patients (a biological factor) could play a role in determining compliance. Members of a diabetic group with greater insulin secretory reserve would be less prone to lapse into ketoacidosis as a result of occasional or temporary medication non-compliance, compared to those belonging to groups with absent β-cell functional reserve. The Hispanic group also had a lower proportion of patients who were treated with insulin before the index DKA episode. The lower rate of insulin dependence among Hispanics, which is a reflection of their

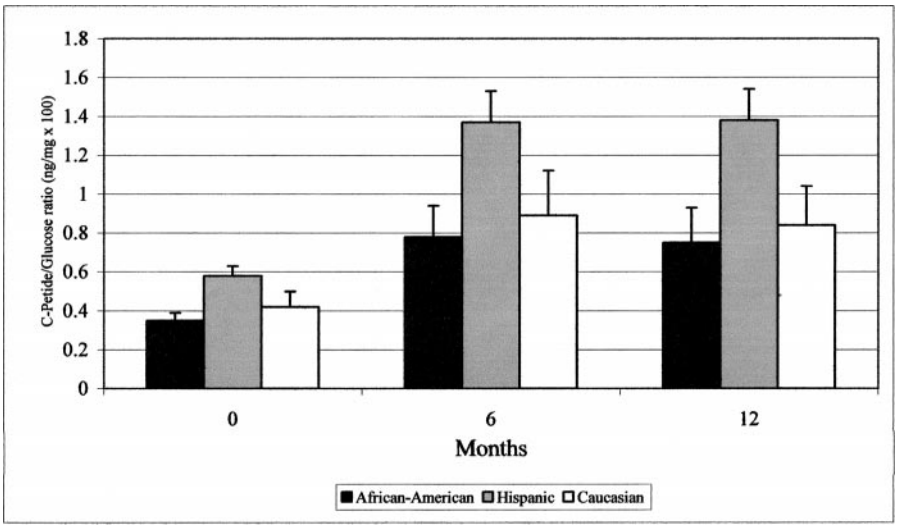

Fig. 1 Differences in the β-cell function as measured by the C-peptide to glucose ratio over time. Values are presented means ± SEM. The number of patients were 321 at 0 months (*P*=.002); 222 at 6 months (*P*=.02); and 178 at 12 months (*P*=.01)

Ketosis-prone Hispanics with diabetes had better preserved β-cell functional reserve, compared to ketosis-prone patients with diabetes belonging to the other 2 ethnic groups . . .

greater β-cell functional reserve, could also contribute to the ethnic differences in the rates of discontinuing insulin use. These differences between Hispanics and patients of the other 2 ethnic groups are consistent with the results of our earlier prospective analysis of the pathophysiology of DKA in multiple ethnic groups.[8] Finally, β-cell functional reserve improved over 6 and 12 months in all 3 ethnic groups, but Hispanics had consistently greater β-cell function than African Americans and Caucasians, at all time points. The improvement in β-cell function is a phenomenon that has been described in ketosis-prone type 2 diabetes. It is most likely secondary to a reversibility of glucose desensitization by aggressively correcting hyperglycemia after the index episode of DKA.[5,8,20,21]

It is commonly believed that the occurrence of DKA in patients with some preservation of β-cell function requires a significantly severe and acute stressful event to overwhelm β-cell function or insulin sensitivity.[1] Consistent with this notion, we noted that acute illnesses were the precipitating factor of the DKA episodes in a significantly higher proportion of Hispanic patients (who, as a group, had better preserved β-cell functional reserve), compared to the African-American and Caucasian patients. However, acute illnesses did not explain the occurrence of DKA in some Hispanics with preserved β-cell functional reserve. It is possible these Hispanic patients had a very severe degree of insulin resistance. The resulting chronic, severe hyperglycemia could have led to glucose desensitization and reversible β-cell failure,[22] making them more prone to ketosis.[23] This, in turn, could be a condition partly due to difficulties in regular access to medical care. If Hispanic patients had less access to medical care, they could have longer periods of uncontrolled hyperglycemia, therefore being more prone to develop DKA, despite fairly adequate β-cell functional reserve. Access to medical care was not systematically examined in the present study; however, difficulties faced by Hispanics in obtaining access to health care in US urban centers have been well-described.[24,25]

The HbA_{1c} at the end of the follow-up period was higher than the therapeutic goal determined by the American Diabetes Association[26] in all 3 ethnic groups. However, this index of chronic glycemic control was significantly higher in the African-American group, compared to the other 2 groups. It is unclear how much of this difference in treatment outcome was due to poor compliance with the treatment regimen, and how much is due to biological factors, such as severe insulin resistance or β-cell dysfunction. Poor compliance with diabetes treatment has been reported to contribute significantly to poor outcomes in cohorts of indigent inner-city African Americans.[2,27]

Several cultural and socioeconomic barriers, such as low literacy rates, limited financial resources, and limited access to health care, have been associated with poor compliance with outpatient diabetes management.[2,28] The educational level was low in all 3 ethnic groups, but was significantly lower in the Hispanic group, of whom only 37% had graduated from high school. The employment rate was also low in all 3 ethnic groups, but was significantly higher in the Hispanic group. It is unclear whether, and how, these disparities might have contributed to differences in the precipitating causes of DKA in the 3 ethnic groups. It should be noted, however, that in the multivariate analysis, neither differences in education level nor employment status were significant predictors of non-compliance.

This study has some limitations, such as that the study sample comprised patients who presented with DKA, and since there could be selection biases, the conclusions are valid for subjects with DKA in the Ben Taub General Hospital. The proportion of Caucasian subjects was smaller than the proportions of African Americans and Hispanics; a larger Caucasian sample may have resulted in different findings. Nevertheless, the ethnic distribution of DKA patients in the present study is very similar to the distribution of the diabetic patients in Harris County Hospital District. Finally, we did not adjust for the duration of insulin therapy before the index episode of DKA, which may have changed some associations.

In conclusion, ketosis-prone Hispanic diabetic patients presenting with DKA are more likely to have preserved β-cell function, compared to African-American or Caucasian patients presenting with DKA. In an indigent, multiethnic population of patients, all participating in a single, public healthcare system, these ethnic differences in β-cell function remain highly significant, after correcting for other factors associated with a preserved β-cell function. Ethnic differences in β-cell functional reserve among ketosis-prone diabetic patients may explain why Hispanics are more likely to develop DKA secondary to acute illnesses, and are less likely to have DKA precipitated by non-compliance with insulin injections. Further, these differences may contribute to the greater dependence of African Americans and Caucasians on insulin therapy. Our results invite further study into the pathophysiologic basis of ethnic differences in β-cell functional reserve and insulin sensitivity, in both ketosis- and non-ketosis-prone diabetic patients.

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