Clinical Characteristics of Type II Diabetic Subjects Consuming High Versus Low Carbohydrate Diets in Mexico City and San Antonio, Texas

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OBJECTIVE — To compare the clinical status of type II diabetic subjects identified in two population-based surveys, one performed in Mexico City, Mexico and the other in San Antonio, Texas.

RESEARCH DESIGN AND METHODS — In a low income area of Mexico City, 3,517 age-eligible (35–64 years of age) individuals were randomly selected of whom 3,319 were interviewed at home and 2,198 were examined in a clinic (response rates 62.5%). In San Antonio, 2,357 similarly aged low-income Mexican Americans were randomly selected of whom 2,076 were interviewed at home and 1,511 were examined (response rate 64.1%). Oral glucose tolerance tests were performed at both sites and diabetes was diagnosed according to the World Health Organization (WHO) criteria. In Mexico City, 288 type II diabetic individuals were identified, and 255 were identified in San Antonio. The following variables were measured: height, weight, subscapular and triceps skinfolds, waist-to-hip circumference ratios (WHR), systolic and diastolic blood pressure (random 0 sphygmomanometer), fasting and 2-h postglucose load glucose and insulin concentrations, and fasting total-cholesterol, HDL-cholesterol, and triglyceride (TG) levels. A food frequency questionnaire was used to estimate total calories and the percentage of calories derived from protein, fat, and carbohydrate. Only type II diabetic patients were included in the analyses. Age-adjustment was performed by analysis of covariance for continuous variables and by the Mantel-Haenszel procedure for discrete variables.

RESULTS — The mean age, the percentage newly diagnosed cases, and the percentage of males were similar in both sites. The percentage of diabetic patients treated with oral agents was significantly higher in Mexico City (56.9 vs. 72.7% in San Antonio and Mexico City, respectively, $P < 0.001$), whereas the percentage treated with insulin was significantly higher in San Antonio (18.8 vs. 2.1% for San Antonio and Mexico City, respectively, $P < 0.001$). A significant difference was observed in the percentage of calories derived from carbohydrate (61.7–63.2 vs. 47.1–47.5% for Mexico City and San Antonio, respectively, $P < 0.001$) and fat (18.4–20.0 and 30.1–33.0% for Mexico City and San Antonio, respectively, $P < 0.001$). Body mass index (BMI) was higher in San Antonio (27.6–30.4 vs. 30.2–32.9% for Mexico City and San Antonio, respectively, $P < 0.05$). Total serum cholesterol was similar at both sites. HDL cholesterol, however, was lower in Mexico City, both in newly and in previously diagnosed patients (30.5–35.8 vs. 39.6–43.3 mg/dl in Mexico City and San Antonio, respectively, $P < 0.001$). TG levels were higher in Mexico City patients (187–249 vs. 167–179 mg/dl in Mexico City and San Antonio, respectively, $P < 0.001$). The association between diabetes and the anthropometric and metabolic variables was similar in Mexico City and San Antonio with the following exceptions: Diabetes in Mexico City was associated with less of an elevation in BMI, WHR, and fasting insulin concentration and less of a reduction in the 2-h postoral glucose load insulin concentration compared with diabetes in San Antonio. In addition, although diabetes was associated with a lower HDL in San Antonio subjects, no association appeared between diabetes and HDL in Mexico City subjects.

CONCLUSIONS — Diabetic subjects in Mexico City were more likely to be treated with oral agents and less likely to be treated with insulin compared with San Antonio patients. Previously diagnosed diabetic subjects in San Antonio had higher BMIs than diabetic subjects in Mexico City. Diabetic subjects in Mexico City ate less fat but more carbohydrate than those in San Antonio. TG levels were higher and HDL-cholesterol levels were lower in Mexico City diabetic subjects compared with those in San Antonio. San Antonio diabetic subjects had lower HDL levels than nondiabetic subjects but, in Mexico City, HDL levels were similar in diabetic subjects and nondiabetic subjects. Postchallenge insulin levels appear to be less suppressed in Mexico City than in San Antonio diabetic subjects.

Over the past several decades a number of studies have shown that differences occur in the prevalence and incidence of type II diabetes among various geographical regions as well as in different ethnic or racial groups (1–3). It is now generally accepted that the sociocultural transformation of certain ethnic groups, i.e., the adoption of a westernized lifestyle, increases the prevalence of diabetes (4,5). We have reported previously that the prevalence of diabetes is approximately one-third higher among low-income Mexican Americans living in San

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WHO, World Health Organization; HDL, high-density lipoprotein; TG, triglyceride; ANCOVA, analysis of covariance; BMI, body mass index; WHR, waist-to-hip circumference ratio; BP, blood pressure; sBP, systolic blood pressure; dBP, diastolic blood pressure; CI, confidence interval.

Antonio than among low income Mexicans living in Mexico City despite similar genetic susceptibility in the two populations (6,7). These findings imply a role for environmental risk factors such as diet and physical activity. Other groups have demonstrated similar results in different populations (8).

In addition, data suggest that different populations exhibit differences in incidence and rate of progression of diabetic complications (9,10). The available information suggests that a major determinant in the pathogenesis of the vascular complications of diabetes is the interplay between genetic susceptibility and environmental influences (11). Moreover, we have demonstrated previously that Mexican Americans with diabetes have a particularly severe form of diabetes, in which the microvascular complications occur with higher frequency than in non-Hispanic white diabetic subjects (12).

In an attempt to further dissect the relative contributions of genetic and environmental influences to the clinical manifestations of diabetes, we compared two groups of diabetic patients who had similar genetic backgrounds but who resided in different environments. We used the San Antonio standardized techniques in both locations to evaluate the clinical, biochemical, and behavioral variables studied.

RESEARCH DESIGN AND METHODS

Study samples

San Antonio. Data from San Antonio subjects were taken from two cross-sectional surveys and one follow-up survey. The first survey (phase I) was conducted from 1979 to 1982. Households were sampled randomly from three types of census tracts: low, middle, and high income. Median incomes for the various census tracts were obtained from the 1970 and 1980 U.S. census data. All 25- to 64-year-old men and nonpregnant women residing in the selected households were considered eligible for the study. Mexican Americans and non-Hispanic whites were classified according to an algorithm published previously (13). The second cross-sectional survey (phase II) was conducted from 1984 to 1988 with an identical neighborhood-based sampling design. An 8-year follow-up of the phase I cohort was started in 1987 (phase III) and completed in 1990. Details of the methodology used in the three phases have been published previously (14–16). Diabetic subjects included in this study are prevalent cases from phase II and III because the waist-to-hip circumference ratio (WHR) was not measured in phase I. The response rate to the phase II and III surveys combined was 64.1%. Because the Mexico City survey involved 35- to 64-year-old individuals living in low income areas, the San Antonio data presented here are restricted to the same age range and to the low income neighborhoods. A total of 255 type II diabetic subjects (see below) who met these criteria were identified in San Antonio.

Mexico City. A total of 6 low income areas (colonias) were selected for study, and a complete enumeration was performed in each colonia. Median incomes for the 6 colonias were obtained from the 1990 Mexican census. All 35- to 64-year-old men and nonpregnant women were considered eligible. Data collection and participant recruitment started in November 1989 and lasted until November 1991. The response rate to the Mexico City survey was 62.5%, and 288 type II diabetic subjects (see below) were identified.

All survey procedures were approved by the Institutional Review Boards of the University of Texas Health Science Center at San Antonio and the Center for Diabetes Studies in Mexico City.

Physical measurements

The procedures were conducted in an identical fashion at both study sites. The anthropometric and hemodynamic variables measured were height, weight, subscapular and triceps skinfolds, WHR, and systolic blood pressure (sBP) (phase 1) and diastolic blood pressure (dBP) (phase 5) (random zero sphygmomanometer, Hawksley-Gelman, Sussex, UK) (14–16). Body mass index (BMI) (kg/m^2) was used as index of overall adiposity. The ratios of WHR and of subscapular-to-triceps skinfold (centrality index) were used as indices of upper-to-lower body adiposity and of central-to-peripheral body fat predominance, respectively. Before beginning the survey, the Mexico City clinic staff traveled to San Antonio and participated in a week-long joint training course with the San Antonio clinic staff. The training course followed procedures that had been used at ~6-month intervals since 1979 during field work for the San Antonio Heart Study. Midway through the survey in Mexico City, one of the Spanish speaking San Antonio clinic staff traveled to Mexico City for several days to observe the staff perform the anthropometric and blood pressure (BP) measurements. She then demonstrated her own technique after which a debriefing session was held and minor differences in technique were reconciled.

Skin reflectance was measured on the inner aspect of the upper arm, a sun-shielded site, using a Photovolt reflectance meter (Photovolt, New York) (17). We have shown previously that these measurements provide as good a measure of native American genetic admixture (low reflectance, i.e., darker color, indicating a higher degree of native American admixture) as a panel of 17 red cell and polymorphic serum protein markers (6,18).

Blood chemistry measurements

Fasting plasma glucose concentration and fasting serum insulin, cholesterol and triglyceride (TG) concentrations were determined using techniques described previously (14,19). Glucose and insulin concentrations were also measured 2 h after a standardized 75-g oral glucose load. In Mexico City, serum was stored at −70°C until shipped to San Antonio on dry ice. All study measurements were performed in the laboratory of the University of Texas Health Science Center at San Anto-

Table 1—*Comparison of demographic and clinical variables in type II diabetic subjects*

	Newly diagnosed		*P* value for city difference	Previously diagnosed		*P* value for city difference
	Mexico City	San Antonio		Mexico City	San Antonio	
n	101	95		187	160	
Age (years)	50.1	50.4	0.861	53.6	56.2	0.002
Male (%)	29.7	29.5	0.897	43.9	32.5	0.020
Diabetes duration (years)	0	0	—	7.7	7.8	0.862
Newly or previously diagnosed (%)	35.1	37.3		64.9	62.7	0.385
Treatment (%)						
Diet only	—	—	—	25.1	24.4	—
Oral hypoglycemic agents	—	—	—	72.7	56.9	0.001*
Insulin	—	—	—	2.1	18.8	—

P values for age-adjusted continuous variables by ANCOVA and for discrete variables by Mantel-Haenszel χ^2. *Global test for effect of city on treatment modality.

nio, Division of Clinical Epidemiology in the Department of Medicine. Diabetes was diagnosed according to WHO criteria (20). Subjects who gave a history of diabetes and who at the time of their clinic examination were taking oral antidiabetic medication or insulin were also considered to have diabetes, regardless of their blood glucose values. Diabetic patients who were not taking insulin were considered to have type II diabetes. Patients taking insulin who had been diagnosed with diabetes before age 40 or whose BMI was <30 kg/m^2 were considered to have possible type I diabetes and were excluded from this analysis. The total number of diabetic subjects thus excluded was 5 in San Antonio and 3 in Mexico City.

Behavioral measurements

Food frequency questionnaires were developed independently for Mexico City and San Antonio subjects, following the approach suggested by Willett et al. (21). Although the two questionnaires had identical formats, each incorporated the most commonly used foods in each site. Both were designed to capture 85% of the total daily intake of calories derived from protein, fat, and carbohydrate. A full description of the development and validation of these instruments has appeared elsewhere (22). The San Antonio instrument was administered to 128 phase III participants representing 75% of all 35- to 64-year-old individuals in one of the low-income area census tracts. Of these individuals, 21 were diabetic and their results are reported in this study. We also administered the San Antonio food frequency questionnaire to a completely independent sample consisting of 76 low-income area Mexican American diabetic subjects, 35–64 years of age, who participated in an on-going family study. These data were examined to see if the nutrient composition of the diets was similar to that of the 21 subjects in this study.

Statistical methods

For continuous variables, age-adjusted cell means were calculated for Mexico City and San Antonio by analysis of covariance (ANCOVA) using the general linear models procedure in SAS (23). One-way ANCOVA was used for newly diagnosed cases and two-way ANCOVA (with sex and city as grouping variables) was used for previously diagnosed cases, because the sex distribution was different in Mexico City and San Antonio for these latter cases (Table 1). Discrete variables were age-adjusted by the Mantel-Haenszel procedure (24) using the age categories of 35–39, 40–49, 50–59, and 60–64 years of age; city differences were tested using the Mantel-Haenszel χ^2 (24). Fasting and 2-h insulin values and TG concentrations were log-transformed for statistical analysis and then back transformed to their natural units for presentation in the tables. Means and SE are presented in the tables for continuous variables, except for variables that had been log transformed, which have 95% confidence intervals (CI) presented.

RESULTS — The demographic and clinical results are presented in Table 1. Patients diagnosed previously in San Antonio were significantly older than patients in Mexico City, although this difference was not observed in newly diagnosed cases. Newly diagnosed cases tended to be younger than previously diagnosed cases in both study sites. In Mexico City, a significant predominance of males was noted in the previously diagnosed group. Because WHR, centrality index, and TG and HDL levels vary by sex, sex-specific analyses of these variables were performed for previously diagnosed cases. The proportion of newly diagnosed cases and the duration of diabetes in previously diagnosed cases were similar in both cities. A similar proportion of patients in San Antonio and Mexico City were treated with diet only, whereas a higher number of patients in Mexico City were treated with oral agents (72.7 vs. 56.9% in Mexico City and San Antonio, respectively) and a lower proportion with insulin (2.1 vs. 18.8% in Mexico City and San Antonio, respectively). A global test revealed this different treatment pattern in the two

Table 2—*Comparison of dietary variables in type II diabetic subjects*

	Newly diagnosed		*P* value for city difference	Previously diagnosed		*P* value for city difference
	Mexico City	San Antonio		Mexico City	San Antonio	
Food frequency questionnaire						
n	101	10		187	11	
Total calories	2139 ± 85	2579 ± 254	0.104	1881 ± 59	1763 ± 254	0.651
Calories (%)						
Carbohydrates	63.2 ± 0.9	47.1 ± 2.7	<0.001	61.7 ± 0.6	47.5 ± 2.5	<0.001
Protein	15.0 ± 0.2	16.4 ± 0.7	0.056	16.4 ± 0.2	19.1 ± 0.8	<0.001
Fat	18.4 ± 0.5	33.0 ± 1.5	<0.001	20.0 ± 0.4	30.1 ± 1.7	<0.001
Family study						
n		25			51	
Total calories		2489 ± 492			2324 ± 605	
Calories (%)						
Carbohydrate		49.1 ± 1.6			48.2 ± 1.1	
Protein		16.3 ± 0.7			18.0 ± 0.5	
Fat		31.7 ± 1.1			31.7 ± 0.8	

Data are means ± SE. *P* values for age-adjusted continuous variables by ANCOVA.

cities to be statistically significant ($P = 0.001$).

Skin reflectance values were nearly identical in the two cities (24.8 vs. 24.8% in San Antonio and Mexico City diabetic men, respectively; and 25.6 vs. 24.4% in San Antonio and Mexico City diabetic women, respectively).

The comparisons of the dietary variables are shown in Table 2. The percentage of calories obtained from protein sources was slightly lower in Mexico City, and this difference was statistically significant in the previously diagnosed group. A significantly higher proportion of calories from carbohydrate sources was reported by the Mexico City diabetic subjects in both diagnostic groups. The percentage of calories derived from fat was significantly higher in the San Antonio diabetic subjects for both diagnostic groups. The nutrient composition of the diets of the 76 low-income Mexican-American diabetic subjects who had participated in the family study was very similar to that of the 21 subjects in this study, which suggests that the results on the latter individuals are generalizable. Interestingly, although lard is thought to be the traditional fat for Mexican cooking, 95% of Mexico City respondents stated that they used primarily vegetable oil for cooking.

The results of the comparisons of the anthropometric and hemodynamic variables are presented in Table 3. BMI was found to be significantly higher in San Antonio diabetic subjects in both diagnostic groups. The ratios of subscapu-

Table 3—*Comparison of anthropometric and hemodynamic variables in type II diabetic subjects*

	Newly diagnosed		*P* value for city difference	Previously diagnosed				*P* values for differences between	
				Men		Women			
	Mexico City	San Antonio		Mexico City	San Antonio	Mexico City	San Antonio	Sex	City
n	101	95		82	52	105	108		
BMI (kg/m^2)	30.4 ± 0.50	32.5 ± 0.50	0.036	27.6 ± 0.64	30.2 ± 0.82	28.5 ± 0.57	32.9 ± 0.57	0.007	<0.001
Centrality index	1.48 ± 0.08	1.55 ± 0.08	0.548	2.08 ± 0.07	1.95 ± 0.09	1.25 ± 0.06	1.31 ± 0.06	<0.001	0.619
WHR	1.00 ± 0.01	0.94 ± 0.01	<0.001	1.00 ± 0.01	0.97 ± 0.01	1.02 ± 0.01	0.93 ± 0.01	*	*
sBP (mmHg)	127 ± 1.8	129 ± 1.9	0.416	130 ± 2.22	133 ± 2.79	121 ± 1.95	130 ± 1.92	0.006	0.013
dBP (mmHg)	77 ± 1.0	75 ± 1.0	0.107	77 ± 1.09	75 ± 1.37	71 ± 0.96	72 ± 0.94	<0.001	0.466

Data are means ± SE. *P* values for age-adjusted continuous variables by ANCOVA. Centrality index = ratio of subscapular-to-triceps skinfold. *Statistically significant sex by city interaction ($P = 0.003$); significant city difference in women only ($P < 0.001$).

Table 4—*Comparison of metabolic variables in type II diabetic subjects*

	Newly diagnosed		P value for city	Previously diagnosed				P values for differences between	
				Men		Women			
	Mexico City	San Antonio	difference	Mexico City	San Antonio	Mexico City	San Antonio	Sex	City
n	101	95		82	52	105	108		
Fasting glucose (mg/dl)	161 ± 6.4	152 ± 6.7	0.307	194 ± 9.1	181 ± 11.2	214 ± 8.0	193 ± 7.8	0.086	0.067
2-h glucose (mg/dl)	297 ± 8.4	282 ± 8.6	0.217	281 ± 23.9	319 ± 13.9	260 ± 25.3	345 ± 10.1	0.903	0.002
Fasting insulin (μU/ml)	21 (18, 24)	23 (20, 27)	0.320	17 (14, 21)	15 (11, 19)	17 (14, 20)	21 (18, 26)	0.106	0.689
2-h insulin (μU/ml)	87 (72, 106)	90 (74, 110)	0.816	52 (32, 86)	35 (27, 46)	95 (57, 157)	59 (49, 73)	0.006	0.037
Total cholesterol (mg/dl)	210 ± 5.4	210 ± 5.6	0.913	197 ± 5.1	205 ± 6.3	201 ± 4.5	221 ± 4.4	0.046	0.008
TG (mg/dl)	249 (224, 277)	179 (160, 199)	<0.001	232 (207, 261)	167 (144, 192)	187 (169, 207)	177 (160, 195)	*	*
HDL cholesterol (mg/dl)	32.9 ± 1.1	40.9 ± 1.1	<0.001	30.5 ± 1.1	39.6 ± 1.4	35.8 ± 1.0	43.3 ± 1.0	<0.001	<0.001
LDL cholesterol (mg/dl)	134 ± 4.7	131 ± 4.8	0.727	124 ± 4.6	132 ± 5.7	127 ± 4.0	141 ± 3.9	0.261	0.020

Data are means ± SE or 95% CI for log-transformed variables. *P* values for age-adjusted continuous variables by ANCOVA. Insulin and TG values were log transformed; numbers in parentheses are 95% CI. Patients taking insulin were excluded from the calculation of the fasting and 2-h insulin values. *Statistically significant sex by city interactions ($P = 0.021$); significant city difference ($P < 0.001$) in men only.

lar-to-triceps skinfold (centrality index) were similar in both study sites for both groups of patients. The comparison of WHR indicate a consistent upper body fat predominance in the Mexico City diabetic patients, which was statistically significant in newly diagnosed cases and in previously diagnosed women. sBP was significantly higher in previously diagnosed San Antonio diabetic subjects, but no other statistically significant BP differences were found between the two cities.

The comparisons between the metabolic variables are presented in Table 4. Similar fasting and 2-h glucose levels were observed in both cities among newly diagnosed cases. Among previously diagnosed cases, Mexico City diabetic subjects had slightly higher fasting (borderline significant) but significantly lower 2-h glucose levels compared with San Antonio diabetic subjects. The fasting and 2-h insulin levels were similar in both cities, except for the 2-h values among previously diagnosed cases, which were significantly higher in Mexico City. Total cholesterol values were similar in newly diagnosed Mexico City and San Antonio patients. However, in the previously diagnosed patients, total cholesterol was significantly higher in San Antonio than in Mexico City. The TG values were higher and the HDL-cholesterol values lower in both newly and previously diagnosed Mexico City patients compared with San Antonio patients. The LDL cholesterol pattern was similar to the pattern for total cholesterol.

Table 5 presents age-adjusted analyses of the association between diabetes and various anthropometric, hemodynamic, and metabolic variables in the two cities. Of particular interest are those variables for which a statistically significant interaction occurs, i.e., for which the association with diabetes differs in Mexico City and San Antonio. Thus, although diabetic patients are more obese in both cities, this association is more marked in San Antonio. A similar pattern was noted for WHR. Mexico City diabetic subjects had higher fasting but lower 2-h glucose values compared with San Antonio diabetic subjects. City differences in fasting insulin levels were minimal, but the patterns of 2-h insulin values were different in San Antonio than in Mexico City diabetic subjects. Thus, whereas Mexico City diabetic subjects were able to augment their 2-h insulin levels above the nondiabetic levels, San Antonio diabetic subjects failed to achieve this level of augmentation. Finally, although HDL cholesterol was lower in Mexico City than in San Antonio in both diabetic and nondiabetic subjects, in Mexico City diabetes was not associated with a further reduction of HDL levels as it was in San Antonio.

CONCLUSIONS— The two study populations are similar in many important respects. Response rates were comparable in both sites, as was the age range and sex distribution. In both cities, we observed the same proportion of newly

Table 5—*Association between diabetes and anthropometric, hemodynamic, and metabolic variables in Mexico City and San Antonio*

	Mexico City		San Antonio		*P* values for differences		
	Diabetic	Nondiabetic	Diabetic	Nondiabetic	City	Diabetic vs. nondiabetic	Interaction
BMI (kg/m^2)	28.9 ± 0.3	28.0 ± 0.1	32.0 ± 0.3	29.4 ± 0.2	<0.001	<0.001	<0.001
Centrality index	1.58 ± 0.04	1.45 ± 0.01	1.53 ± 0.04	1.42 ± 0.02	0.747	<0.001	0.689
WHR	0.99 ± 0.005	0.97 ± 0.002	0.93 ± 0.005	0.89 ± 0.002	<0.001	<0.001	0.031
sBP (mmHg)	122 ± 0.96	117 ± 0.37	126 ± 1.0	124 ± 0.47	<0.001	<0.001	0.191
dBP (mmHg)	75 ± 0.6	73 ± 0.2	73 ± 0.6	73 ± 0.3	0.051	0.044	0.138
Fasting glucose (mg/dl)	188 ± 1.9	85 ± 0.7	172 ± 2.0	88 ± 0.9	<0.001	<0.001	<0.001
2-h glucose (mg/dl)	287 ± 3.8	105 ± 1.0	308 ± 2.9	112 ± 1.3	<0.001	<0.001	<0.001
Fasting insulin (μU/ml)	17.6 (16, 19)*	12.2 (12, 13)	19.8 (18, 22)*	11.4 (11, 12)	0.463	<0.001	0.008
2-h insulin (μU/ml)	78.9 (68, 92)*	70.5 (68, 73)	59.1 (53, 67)*	71.6 (68, 75)	0.008	0.448	0.003
Total cholesterol (mg/dl)	201 ± 2.5	190 ± 1.0	209 ± 2.7	200 ± 1.2	<0.001	<0.001	0.530
TG (mg/dl)	218 (205, 232)	173 (169, 177)	171 (160, 182)	131 (127, 135)	<0.001	<0.001	0.535
HDL cholesterol (mg/dl)	32.8 ± 0.6	32.9 ± 0.2	41.2 ± 0.7	46.4 ± 0.3	<0.001	<0.001	<0.001
LDL cholesterol (mg/dl)	127 ± 2.3	123 ± 0.9	132 ± 2.5	125 ± 1.1	0.032	0.003	0.521

Data are means ± SE or 95% CI for log-transformed variables. *P* values for age-adjusted continuous variables by ANCOVA. Insulin and TG values were log transformed; numbers in parentheses are 95% CI. *Patients taking insulin were excluded from the calculation of the fasting and 2-h insulin values.

and previously diagnosed cases, which suggests similar levels of access to healthcare services. The skin reflectance data suggest that diabetic subjects from the two populations have approximately the same degree of native American genetic admixture. However, a number of differences are found between the two sites. For example, diabetes management differs in Mexico City in that oral agents are more commonly used and insulin is less commonly used. We think that these differences result from a combination of physician and patient preference. It should not be surprising that the use of oral agents is so widespread and that the use of insulin therapy is so restricted in Mexico City compared with San Antonio, because there is a general belief in Mexico City and possibly the entire country that insulin reduces visual acuity and might lead to blindness. Conceivably, this difference in therapeutic approaches could influence the incidence and rate of progression of vascular complications. The frequency of self-reported diet therapy observed in Mexico City may be overestimated, because clinical impression suggests that many patients are simply on unrestricted diets and do not accept pharmacological therapy.

The analysis of the total caloric intake and the percentage of calories distributed from protein, fat, and carbohydrate reveals that 62–63% of calories consumed by Mexico City diabetic subjects are derived from carbohydrate and only 18–20% from fat. Adequate performance of our diet questionnaires for international comparisons has been demonstrated previously (22). Although the frequency questionnaire was only administered to 21 diabetic subjects in San Antonio, the similarity of the nutrient composition of the diet estimated for this group to that of a larger number of San Antonio diabetic subjects, who answered the same questionnaire as part of a separate family study, supports the validity of the frequency data on the former. The dietary differences between Mexico City and San Antonio might explain the tendency toward hypertriglyceridemia observed in the Mexico City diabetic subjects. Although an ecological association between high carbohydrate intake and hypertriglyceridemia does not by itself prove cause and effect, a large body of metabolic ward data supports the concept that high carbohydrate feedings can induce increases in TG and decreases in HDL-cholesterol concentrations (25,26). The higher BMIs observed in the San Antonio diabetic subjects could result, at least in part, from these dietary differences because high-fat diets may result in weight gain (27–29).

It is interesting to speculate on the possible atherogenic potential of high carbohydrate diets, hypertriglyceridemia, and low HDL concentrations in Mexico City diabetic subjects, particularly considering that their consumption of 62–63% of calories from carbohydrate is quite close to the 55–60% recommended by the American Diabetes Association (30). In many parts of the world, particularly in developing societies, this dietary and lipid pattern is associated with very low rates of cardiovascular disease (31,32). On the other hand, such societies typically have low rates of diabetes as well. Coulston et al. (25,26) have cautioned that high carbohydrate diets, whatever their effects on nondiabetic individuals, may be undesirable for diabetic subjects. Moreover, although Mexico City

is still regarded as a developing society, it appears to be rapidly approaching the stage where the health problems usually associated with the developed world are gaining ascendancy. For example, the prevalence of type II diabetes in Mexico City is already higher than among non-Hispanic whites in the U.S. and only about one-third lower than in U.S. Mexican Americans (6). Also, Mexico City residents are more obese than non-Hispanic whites in the U.S. (6) and, as shown in Table 5, they are nearly as obese as Mexican Americans in San Antonio. Thus, it remains to be seen if the dietary and lipid patterns that appear relatively benign in the developing world will remain so as societies like Mexico become increasingly developed. We are currently conducting a follow-up study of these patients that includes noninvasive measures of atherosclerosis that will hopefully shed light on this important public health problem.

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