Type 2 Diabetes Is Prevalent and Poorly Controlled Among Hispanic Elders of Caribbean Origin

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A B S T R A C T

Objectives. We estimated prevalence and control of type 2 diabetes in Puerto Rican, Dominican, and non-Hispanic White (NHW) elders and associated them with sociodemographic and health behavior variables and with body mass index (BMI) and waist circumference.

Methods. We used a cross-sectional analysis with a sample of Hispanic elders in Massachusetts and a comparison group of NHWs (1991–1997). The analysis included 379 Puerto Ricans, 113 Dominicans, and 164 NHWs, aged 60 to 96 years, with complete questionnaires and blood samples.

Results. Type 2 diabetes was significantly more prevalent among Puerto Ricans (38%) and Dominicans (35%) than among NHWs (23%). Differences remained after covariates were adjusted for. Hispanics with diabetes were approximately 3 times more likely to use insulin than NHWs. Puerto Ricans were 2 times, and Dominicans 3 times, more likely to have glycosylated hemoglobin concentrations of 7% or above than NHWs. BMI and waist circumference were individually associated with diabetes. When included in the model together, waist circumference, but not BMI, remained independently associated with diabetes.

Conclusions. Ethnicity was more strongly associated with diabetes status and control than were socioeconomic or measured health behavior variables, suggesting that genetic or other culturally related factors may explain these differences. (*Am J Public Health*. 2000; 90:1288–1293)

Type 2 diabetes poses a major health threat worldwide. In 1997, according to the Centers for Disease Control and Prevention, 10.3 million persons reported that they had diabetes, and it is estimated than 5.4 million people have undiagnosed diabetes.[1] Although these figures represent diabetes of all types, 90% to 95% of people with diabetes have type 2 diabetes.[2] People with diabetes are prone to acute and long-term complications. The prevalence of type 2 diabetes has been positively associated with age and minority status.[3] Diabetes is 2 to 3 times more prevalent among those older than 65 years than among those aged 20 to 44 years.[3] However, a lowering of prevalence among the oldest old has also been observed and is attributable to diabetes-related mortality.[4]

Rates of diabetes are generally higher among African Americans and Hispanics than among non-Hispanic Whites (NHWs), and rates have been reported to be 25% higher among Hispanics than among African Americans.[3] This is of great concern, given that the Hispanic population is the fastest-growing minority group in the United States. A recent review of diabetes among Hispanic Americans summarized the available data on diabetes prevalence.[5] Most published studies concerning Hispanics focused on Mexican Americans, including those studies that used data from San Antonio, Tex,[6] the San Luis Valley, Colo,[7] and Albuquerque, NM.[8] Prevalences ranged from 12% for adults aged 60 to 69 years in Albuquerque to 33% among those aged 55 to 64 years in "transitional" neighborhoods in San Antonio.

Few studies have included Puerto Ricans or other Hispanics of Caribbean origin. The Hispanic Health and Nutrition Examination Survey (HHANES; 1982–1984) reported that 26% of Puerto Ricans and 24% of Mexican Americans between 45 and 74 years of age had diabetes.[9] A concurrent (1981–1985) study in Puerto Rico reported lower prevalences than those seen in the HHANES: 14% and 19% for those aged 45 to 64 years and those 65 years and older, respectively.[10]

Control of diabetes is of critical importance in the prevention of serious complications, including neuropathy, nephropathy, and retinopathy. The Diabetes Control and Complications Trial showed that intensive control could be very effective in delaying the onset and slowing the progression of these complications.[11] Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed that minority patients in the United States with type 2 diabetes were likely to have poor glycemic control.[12] Among those with diabetes, 50% of non-Hispanic Black women and 45% of Mexican American men, compared with 35% to 38% of NHW adults, had glycosylated hemoglobin concentrations above 8%, which placed them at high risk of long-term complications. Hispanics of Caribbean origin were not represented in that survey.

Type 2 diabetes is a multifactorial disease, with both inheritance and environment making fundamental contributions to its pathogenesis.[13] Published clinical and epidemiologic evidence suggests that potentially modifiable risk factors for diabetes include obesity, body fat distribution, and lifestyle factors such as physical activity, dietary pattern, cigarette smoking, and alcohol use.[14] Aging is also associated with diabetes, owing to a progressive decline in glucose tolerance and abnormal carbohydrate metabolism.[15] Among immigrant groups, low accul-

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turation may also affect risk for diabetes, through limitations in language skills, employment, and education.[6] Socioeconomically disadvantaged and less educated minority populations may also be less likely to follow health preventive measures and regular medical treatments.[3]

In this study, we examine the prevalence of type 2 diabetes among a representative sample of Puerto Rican and Dominican elders in the state of Massachusetts—groups that have not been extensively studied previously. We also examine prevalence in a neighborhood-based comparison group of NHWs. Finally, we relate ethnicity, measures of socioeconomic status, health behaviors, and body weight to the presence of diabetes and, among those with diabetes, to measures of treatment and control.

Methods

Sampling and Subject Location

The sampling and subject location for this study has been described previously.[16] Briefly, we used the 1990 census data in Massachusetts in a 2-stage method,[17] which first allowed counties to randomly fall into the sample (multiple times or not at all) proportionate to the size of the Hispanic population 55 years and older. Within these selected counties, we randomly sampled census blocks in which at least 2 Hispanic elders 55 years or older were reported in 1990. Subjects were then located through door-to-door enumeration. When 2 or more eligible subjects resided in the same household, 1 was selected randomly. NHW elders in the same census blocks were located simultaneously.

In total, 941 eligible Hispanics and 465 NHWs were invited to participate and 779 Hispanics (83%) and 251 NHWs (54%) were interviewed between 1992 and 1997. Participation rates were greater for Dominicans (90%) and Puerto Ricans (86%) than for the remaining Hispanics (70%). Because the NHW group is a neighborhood comparison group, their socioeconomic indicators are closer to the population of Hispanic elders than would be seen with a random sample of NHWs. The remaining Hispanics were of various Hispanic origins, including Cuban, Central and South American, and Mexican. Because of that heterogeneity, we include only the Puerto Rican, Dominican, and NHW subjects in this analysis.

A total of 863 subjects had complete questionnaires (473 Puerto Ricans, 140 Dominicans, and 250 NHWs). Of these subjects, 379 Puerto Ricans, 113 Dominicans, and 164 NHWs also provided usable blood samples and were included in this analysis. Subjects without blood data were significantly older than those with blood measurements (72 vs 70 years); however, there were no significant differences between groups in sex distribution, education level, poverty status, smoking status, or alcohol use.

Data Collection

The field methodology for this study was approved by the Human Investigations Review Board at the New England Medical Center/Tufts University. Diabetes status was determined with the most recent guidelines of the American Diabetes Association.[18] We considered subjects to have diabetes if they had a fasting plasma glucose concentration of at least 126 mg/dL or a random plasma glucose concentration of greater than 200 mg/dL, or if they were using prescribed oral medication for diabetes or insulin. For epidemiologic studies with a single blood sample, as in this study, the American Diabetes Association guidelines state that estimates of prevalence should be based on a fasting blood glucose concentration cutoff of 126 mg/dL or above.[18]

Anthropometric measurements were taken in duplicate by trained interviewers, and the average of the 2 measures was used. Stature and knee height were taken with a Harpenden pocket stadiometer (Holtain Ltd, Crosswell, UK). Weight was measured with a Seca balance scale (Seca Corporation, Columbia, Md) with a capacity of 150 kg and graduation of 500 g; the scale was calibrated regularly with known weights. For subjects unable to stand or with a stooped posture, stature was estimated from knee height through equations developed for these Hispanic subjects[19] and existing published equations for NHWs.[20] Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured to the nearest tenth of a centimeter with a nonstretchable measuring tape held at the level of the smallest area of the waist.

Information on age, years of education, income, physical activity, and alcohol and tobacco use was collected by questionnaire, as was diabetes-related information (age at diagnosis, use of insulin and/or oral medications, and diabetes complications). Most of the instruments selected were similar to those used in the HHANES and therefore have been successfully used with Hispanic populations. Other instruments were translated into Spanish and translated back into English for verification of translation. All methods were pretested for clarity with subjects similar to those in the target population before the beginning of formal data collection. Interviewers were fully bilingual.

Alcohol use and smoking were each categorized into the following 3 groups: current use, never use, and former use. Medication use was verified by observing actual medications in the home. Income was calculated from employment, public assistance, retirement pensions, and other sources for all members of the household. At least 1 income item was missing for 103 subjects; for them, income was imputed from other existing socioeconomic information by the Expectation Maximization Procedure in the Statistical Packages for the Social Sciences.[21]

Physical activity was estimated with a modified version of the Harvard Alumni Physical Activity Questionnaire.[22] With this instrument, the respondent is asked for the number of hours per day (mean of a regular weekday and a regular weekend day) spent sleeping, sedentary (sitting), and engaged in light, moderate, and heavy (vigorous) activities, with the interviewer probing to ensure that the total hours equal 24. The time spent in each of these activity categories is multiplied by the weighting factors 1.0, 1.1, 1.5, 2.4, and 5.0, respectively.[23,24] The lowest possible score, therefore, is equal to 24. We used 29 as a conservative cutoff score for sedentary activity, assuming 8 hours of sleep, 8 hours of sitting, and 8 hours of light activity.

At the time of the interview, an appointment was made for a phlebotomist to return to obtain a fasting blood sample, usually within the following week. Blood was analyzed for glucose by the hexokinase enzymatic method (Sigma Diagnostics, St Louis, Mo) and complete blood count the same day it was drawn. Samples were then stored at −70°C and later analyzed for glycosylated hemoglobin with the GlycotestII (Pierce Chemical Co, Rockford, Ill). Subjects, along with their doctors if they so chose, were informed if any values were abnormal. Once all blood analyses were complete, subjects were sent a final report of their laboratory results.

Data Analysis

Statistical analysis was completed with SAS (SAS System for Windows, Release 6.12 TS; SAS Institute, Inc, Cary, NC). Prevalence estimates for diabetes were obtained by sex and ethnic group. Among subjects with diabetes, the percentages who used insulin and oral medications and reported diabetes complications (kidney disease, amputations, and ulcerations of extremities) were described, along with the length of time with diagnosed diabetes. Logistic regression models were used to test the differences in prevalence across ethnic groups, adjusted for age and sex.

The presence or absence of diabetes was regressed on ethnicity (with variables for Puerto Ricans and for Dominicans vs NHWs), age, sex, poverty status, years of education, physical activity score, smoking, alcohol use, BMI, and waist circumference. Interactions between ethnicity and the other variables were tested and, when not significant at $P < .01$, were removed from the equations. Main-effect variables that were not significant at $P < .05$ were removed in sequential steps to obtain the most parsimonious model. Age, sex, BMI, waist circumference, and ethnicity were retained in all models, however, as basic control variables.

The above set of analyses was repeated among those with diabetes only for 2 dependent variables, use of insulin (yes/no) and high glycosylated hemoglobin (≥7%; yes/no). We selected 7% as the cutoff point for high glycosylated hemoglobin on the basis of the American Diabetes Association's clinical practice recommendations for self-management goals.[25] The variable years with diagnosed diabetes (calculated from self-reported age at diagnosis) was also added as a predictor of insulin use. For the glycosylated hemoglobin models, the use of insulin (yes/no) and of oral diabetes medications (yes/no) was also included to determine whether high glycosylated hemoglobin concentrations remained after these treatment variables were adjusted for.

TABLE 1—Description of the Diabetes Study Population

	Puerto Rican (n = 379)	Dominican (n = 113)	NHW (n = 164)
Age, mean ± SD	69.1 ± 7.4**	68.3 ± 6.8**	71.2 ± 7.4
Sex, % women	56.2	68.1	59.1
Years of education, mean ± SD	4.5 ± 4.1***	5.1 ± 4.1***	11.8 ± 3.8
Poverty, % below poverty level	60.4***	63.7***	27.4
Smoking, %			
Never smoked	40.1	61.9***	34.8
Former smoker	42.2**	27.4	32.9
Current smoker	17.7***	10.6***	32.3
Alcohol use, %			
Never	37.3***	50.9***	20.7
Former	42.6	27.0*	40.9
Current	20.1***	21.4***	38.4
Physical activity score, mean ± SD	28.9 ± 2.8*	29.6 ± 3.2	29.5 ± 3.4
BMI, mean ± SD	27.9 ± 5.5	28.6 ± 5.6	27.5 ± 6.1
Waist circumference, mean ± SD	97.6 ± 13.2	98.3 ± 11.6	97.6 ± 15.2

Note: NHW = non-Hispanic White; BMI = body mass index.
*$P < .05$; **$P < .01$; ***$P < .001$ for Puerto Rican or Dominican vs NHW, adjusted for age and sex, using general linear models procedure in SAS or logistic regression models as appropriate.

TABLE 2—Prevalence of Type 2 Diabetes Mellitus in the Study Population

	Puerto Rican (n = 379)	Dominican (n = 113)	NHW (n = 164)
Diabetes prevalence (%)	38.3***	34.5	22.6
Men (%)	35.5**	25.0	19.4
Women (%)	40.4*	39.0	24.7
Self-reported diabetes	34.3**	29.2	20.7
Individuals with diabetes who did not self-report (% of population)	6.1	8.0	5.5

Note. NHW = non-Hispanic White.
*$P < .05$; **$P < .01$; ***$P < .001$ for Puerto Rican or Dominican vs NHW, adjusted for age and sex, when appropriate, with logistic regression models.

Results

Characteristics of the study population are presented in Table 1. Comparisons across ethnic groups were adjusted for age and sex, as appropriate. NHWs were significantly older, had higher education, and were less likely to have incomes below the poverty level than were either Puerto Ricans or Dominicans. NHWs were also more likely to be current smokers and alcohol users than was either Hispanic group. Both NHWs and Puerto Ricans were more likely than Dominicans to be former drinkers, and Puerto Ricans were more likely to be former smokers. The Puerto Ricans, but not the Dominicans, had significantly lower physical activity scores than the NHWs. There were no significant differences between NHWs and either Hispanic group for sex distribution, BMI, or waist circumference.

Diabetes Prevalence

The prevalence of diabetes (Table 2) was relatively high for all of the ethnic groups in this generally low-income sample. More than 38% of the Puerto Ricans and almost 35% of the Dominicans had diabetes, compared with almost 23% of the NHWs. During the interview, we asked subjects whether a physician had ever told them that they had diabetes. In this sample, most subjects knew if they had diabetes: the proportions who self-reported diabetes were only slightly lower than the proportions whom we identified as having diabetes, with the greatest discrepancy seen among Dominicans (29% vs 35%) and the least among the NHWs (21% vs 23%).

Information on the subset of the sample with diabetes is provided in Table 3 by ethnic group. Puerto Ricans and Dominicans tended to report earlier ages at diagnosis (55 and 59 years, respectively) than did NHWs (61 years). Oral medication use was similar across groups. Puerto Ricans were approximately 3 times and Dominicans 2 times more likely than NHWs to be using insulin (although the latter comparison was not significant). As measured by glycosylated hemoglobin concentrations of 7% or above, diabetes was significantly more likely to be uncontrolled in both Puerto Ricans and Dominicans than in NHWs (62%, 63%, and 39%, respectively), even after insulin use was adjusted for. Although the numbers are insufficient for stable estimates, the reported history of complications from diabetes reflected the greater apparent lack of diabetic control among Puerto Ricans. While none of the NHWs reported kidney disease and only 1 reported amputations or ulcerated limbs, almost 8% and 6%, respectively, of Puerto Ricans reported these conditions. No com-

TABLE 3—Diabetes Indicators by Ethnic Subgroup

	Puerto Rican (n=145)	Dominican (n=39)	NHW (n=37)
Age at diagnosis, mean ± SD[a]	55.4 ± 13.0	58.6 ± 8.9	60.9 ± 8.9
Years with diagnosed diabetes, mean ± SD[a]	13.8 ± 11.6	10.8 ± 10.7	9.1 ± 8.1
Using oral medication, %[a]	46.9	42.4	50.0
Using insulin, %[a]	50.8**	36.4	17.6
High glycosylated hemoglobin,[b] %	62.0*	63.2*	38.9
Kidney disease, %[a]	7.7	0.0	0.0
Amputations or ulcerated limbs, %[a]	6.2	0.0	2.9

Note. NHW = non-Hispanic White.
[a]Based on self-reported diabetes.
[b]High glycosylated hemoglobin ≥ 7.0%.
*P < .05; **P < .01 for Puerto Rican or Dominican vs NHW, adjusted for age and sex, using general linear models procedure in SAS or logistic regression models as appropriate.

plications were reported in this group of Dominicans with diabetes.

Multiple Logistic Models

The results of the logistic regression of diabetes (yes/no), use of insulin (yes/no), and high glycosylated hemoglobin (yes/no) on ethnicity, BMI, waist circumference, and other sociodemographic and health behavior variables are presented in Table 4. The significantly greater prevalence of diabetes among both Hispanic groups than among NHWs remained after this set of potentially confounding or explanatory variables was adjusted for (odds ratio [OR] = 2.3 and 1.9 for Puerto Ricans and Dominicans, respectively). Other variables that related significantly to the presence of diabetes in this fully adjusted model were female sex, lower physical activity score, and greater waist circumference. Because BMI and waist circumference were highly correlated (r = 0.82), we repeated the model with each of these variables separately. When included separately, each was significant. When included together, BMI did not contribute to diabetes risk independently of waist circumference, but waist circumference remained associated with diabetes status independently of BMI.

Among those subjects with diabetes, the logistic regression of insulin use on the set of variables described above, plus number of years with diabetes, showed that Puerto Ricans and Dominicans were almost 3.5 and 2.6 times more likely, respectively, to be using insulin than were NHWs. This difference was significant for Puerto Ricans, but not for Dominicans (P = .18). Years with diabetes was the only other variable significantly associated with insulin use, although greater waist circumference approached significance (P = .10) in this full model, which included BMI. When included separately, BMI and waist circumference were each significantly associated with insulin use. After their greater insulin use and use of oral medications were adjusted for, Puerto Ricans and Dominicans remained 2.4 and 3.0 times more likely than NHWs to have high glycosylated hemoglobin concentrations (≥7%).

TABLE 4—Characteristics Associated With Diabetes and Diabetes Indicators Among Hispanic (Puerto Rican and Dominican) and non-Hispanic White (NHW) elders[a]

Characteristic	Diabetes OR (95% CI)[b] (n=656)	Use of Insulin OR (95% CI)[c] (n=221)	High Glycosylated Hemoglobin (≥7.0%) OR (95% CI)[d] (n=221)
Puerto Rican vs NHW	2.30 (1.46, 3.64)	3.46 (1.09, 11.05)	2.39 (1.03, 5.54)
Dominican vs NHW	1.87 (1.06, 3.32)	2.57 (0.65, 10.12)	3.11 (1.13, 8.59)
Sex: male vs female	0.65 (0.43, 0.97)	1.39 (0.60, 3.25)	0.88 (0.44, 1.73)
Age (years)	1.00 (0.98, 1.03)	0.97 (0.92, 1.03)	1.00 (0.96, 1.05)
Physical activity score	0.92 (0.86, 0.98)	. . .	. . .
BMI	0.99 (0.94, 1.06)	0.98 (0.85, 1.12)	1.01 (0.91, 1.12)
Waist circumference	1.03 (1.01, 1.06)	1.05 (0.99, 1.11)	1.02 (0.97, 1.06)
Years with diabetes	. . .	1.11 (1.07, 1.16)	. . .
Using insulin (yes/no)	. . .	. . .	2.83 (1.42, 5.64)
Using oral medications (yes/no)	. . .	. . .	2.30 (1.20, 4.44)

Note. OR = odds ratio; CI = confidence interval; BMI = body mass index.
[a]Other variables tested and removed when nonsignificant at P < .05 include poverty status, education, physical activity, alcohol intake, and smoking status.
[b]Models containing BMI (1.06 [1.03, 1.10]) or waist circumference (1.03 [1.02, 1.05]) separately were also tested.
[c]Subjects with type 2 diabetes only; models containing BMI (1.08 [1.00, 1.16]) or waist circumference (1.04 [1.01, 1.07]) separately were also tested.
[d]Subjects with type 2 diabetes only; models containing BMI (1.04 [0.98, 1.11]) or waist circumference (1.02 [1.00, 1.04]) separately were also tested.

Discussion

In this study, we have documented the extremely high prevalence of diabetes among this generally low-income group of Hispanics of Caribbean origin, aged 60 to 96 years, in Massachusetts. We have also shown that this excess prevalence among Puerto Ricans and Dominicans, when those groups are compared with NHW neighborhood controls, is persistent, even after factors commonly associated with diabetes are adjusted for. Although there was a tendency toward higher prevalence of diabetes complications among Puerto Ricans than among NHWs, limitations in sample size, particularly for the group of NHWs with diabetes, prevent clear conclusions at this time. Both of these population subgroups, particularly the Dominicans, have been inadequately studied, and almost no previous studies have examined these issues among this older age group of Hispanics of Caribbean origin.

It is difficult to compare the prevalence figures seen here with those of other studies. In addition to having a group that was older than in most other studies, we used the most recent guidelines for the definition of diabetes,[18] which included lower cutoff points for fasting blood glucose concentrations than in earlier guidelines. The prevalences reported here exceed those previously reported, but they are consistent with those from preceding studies in showing that Hispanics in general

are more likely to have diabetes than are NHWs. Vital statistics reports from the American Diabetes Association have described higher prevalences of both diagnosed diabetes and total (sum of diagnosed and undiagnosed) diabetes for persons of Mexican and Puerto Rican descent, compared with NHWs and African Americans. For those aged 45 to 74 years, the prevalence of diagnosed diabetes has been reported to range from 6% in NHWs to 10% in African Americans and 14% in Mexican Americans and Puerto Ricans.[26] In the HHANES, Puerto Rican adults (aged 20–74 years) were found to have slightly higher rates than Mexican Americans (26% and 24%, respectively), and the rates for both of these groups were greater than the prevalence among NHWs (12%).[9] Most recently, results from the Hispanic Established Populations for Epidemiologic Studies of the Elderly showed that the prevalence and health burden of self-reported diabetes were greater in older Mexican Americans than in older NHWs or African Americans.[4]

Rates of undiagnosed diabetes in our sample are much lower than those reported for other ethnic groups with similar socioeconomic status. For example, the HHANES found that in the population aged 45 to 74 years, 14% of Puerto Ricans and 11% of Mexican Americans with diabetes did not correctly self-report their status.[9] These rates are higher than those reported for NHWs in NHANES II, where 7% of the individuals in this age group were found to have diabetes with no prior diagnosis. In contrast, we found that only 6% of Puerto Ricans and 8% of Dominicans had undiagnosed diabetes in this sample. One difference is that our group was older, and individuals may have been more likely to be identified as having diabetes because of their age. It may also be that the health care environment in which these groups live contributes to better access to screening and diagnosis than is available in other parts of the country. However, a recent study of diabetes among Caribbean Hispanics in the Boston area found lower follow-up care, poor dietary compliance, and only limited home blood glucose monitoring.[27] This is consistent with our findings that despite the apparently high awareness of their state of health, a large proportion of these subjects with diabetes have poor control of their condition.

We found that among subjects with diabetes, insulin use was significantly more likely among Puerto Ricans than NHWs. Data from the NHANES II and the HHANES also showed greater insulin use among Puerto Ricans (29%) than among NHWs (23%).[28] Despite pharmacologic treatment with insulin and oral medications, Hispanic elders in this study remained at higher risk of uncontrolled diabetes than NHWs—as shown by a high proportion of individuals with glycosylated hemoglobin at or over 7%, a concentration associated with increased risk for long-term complications.[25] A recent report from the NHANES III also found that ethnic minorities (non-Hispanic Blacks and Mexican Americans) had poorer glycemic control than did NHWs,[12] but the report did not include data on Hispanics of Caribbean origin.

These findings raise several interesting questions that deserve further follow-up. It is likely that greater insulin use is due to elevated glucose and glycosylated hemoglobin levels, which signal the need for more frequent treatment with insulin. The question that follows, however, is why Hispanics appear less able to control their condition. A constellation of metabolic, genetic, and environmental factors play a role in the development and progression of diabetes.[11] Proper care of diabetes is essential because no known cure exists and good management can reduce the frequency of complications.[11] Diabetes management requires education and surveillance of risk factors that may apply differently to different ethnic groups.[18] It is likely that language barriers and other factors associated with the health care of Hispanics relative to that of NHWs are important to the ethnic difference in diabetes control, and further investigation is needed.

In this study, we found higher prevalences of diabetes among Puerto Ricans and Dominicans than among NHWs after known risk factors were adjusted for. In addition to ethnicity, female sex, low physical activity score, and greater waist circumference were significantly associated with diabetes presence or control in at least 1 of the models. Inverse associations between physical activity and insulin level have been observed,[29,30] suggesting a direct effect of physical inactivity on insulin resistance. The proportion of diabetes risk attributable to physical inactivity has been estimated at 24%.[31] Physical inactivity has been shown to be higher among people older than 45 years, noncollege graduates, and minorities.[32] The high prevalence of chronic diseases and functional limitations among socioeconomically disadvantaged older adults, and the importance of physical activity to health and quality of life, suggest that social and behavioral interventions to increase exercise within this population may prove valuable.[33]

Contrary to expectations, we did not find socioeconomic factors to be significantly associated with diabetes prevalence or insulin use among these Hispanics of Caribbean origin. The San Antonio Heart Study did see a significantly higher prevalence of diabetes among women, but not men, in the lowest vs the highest socioeconomic strata.[6] The investigators concluded, however, that culturally mediated factors may be more important than socioeconomic status in the development of diabetes.

Obesity is a well-known risk factor for type 2 diabetes.[7,14,34–43] Although BMI is a widely used measure of obesity, it may represent a different degree of adiposity in different racial groups. Greater waist–hip ratio, with a pattern of body fat that is disproportionately distributed in the central abdominal region, has also been associated with both increased prevalence and incidence of diabetes.[14,44] The San Antonio Heart Study[41] also found that waist–hip ratio had a higher sensitivity and lower false-positive rate for identification of prevalent cases of type 2 diabetes than did BMI.

More recently, waist circumference was found to be an even stronger predictor of type 2 diabetes than either waist–hip ratio or BMI among 721 Mexican Americans (aged 25–64 years) followed for 7 years.[37] In that study, the predictive value of a single waist circumference measurement was at least equal to that of waist–hip ratio and BMI combined. In at least 1 other study, waist circumference correlated with the level of abdominal visceral adipose tissue more strongly than did waist–hip ratio.[45] We therefore used waist circumference rather than waist–hip ratio in this study. Consistent with previous findings in other groups, we found that waist circumference and BMI were each significantly associated with diabetes prevalence, but that the significance of BMI disappeared after waist circumference was adjusted for, while waist circumference remained significant independently of BMI. Years with diabetes and central adiposity were also associated with insulin use among Puerto Ricans and Dominicans.

In conclusion, we have demonstrated that elderly Puerto Ricans and Dominicans in Massachusetts have higher prevalences of diabetes than do NHWs and that among those with diabetes, Puerto Ricans and Dominicans have poorer control of their conditions than do NHWs living in the same neighborhoods. These excess prevalences do not diminish with adjustment for other known risk factors, including physical activity and body size, and the differences in control remain after medication use is adjusted for. The persistence of these differences and the lack of significant associations with socioeconomic factors suggest that genetics or cultural factors that may be unique to these Hispanic subgroups are likely to play important roles in their higher prevalence of type 2 diabetes. Language barriers, health care access, level of acculturation, and practices of diabetes self-care may contribute to higher risk of long-term diabetes complications and deserve further examination. These pose a challenge for the many

community-based programs that are reaching out to this high-risk population. □

Contributors

K. L. Tucker designed the study and the data analysis and wrote the paper. O. I. Bermudez analyzed the data and contributed to the designing of the sudy and the writing of the paper. C. Castaneda contributed to the interpretation of the data and contributed substantially to the writing of the paper.

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