Diabetes in Hispanic American Youth

Prevalence, incidence, demographics, and clinical characteristics: the SEARCH for Diabetes in Youth Study

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OBJECTIVE — To report the 2001 prevalence and 2002–2005 incidence of type 1 and type 2 diabetes in Hispanic American youth and to describe the demographic, clinical, and behavioral characteristics of these youth.

RESEARCH DESIGN AND METHODS — Data from the SEARCH for Diabetes in Youth Study, a population-based multicenter observational study of youth aged 0–19 years with physician-diagnosed diabetes, were used to estimate the prevalence and incidence of type 1 and type 2 diabetes. Information obtained by questionnaire, physical examination, and blood and urine collection was analyzed to describe the characteristics of youth who completed a study visit.

RESULTS — Among Hispanic American youth, type 1 diabetes was more prevalent than type 2 diabetes, including in youth aged 10–19 years. There were no significant sex differences in type 1 or type 2 diabetes prevalence. The incidence of type 2 diabetes for female subjects aged 10–14 years was twice that of male subjects ($P < 0.005$), while among youth aged 15–19 years the incidence of type 2 diabetes exceeded that of type 1 diabetes for female subjects ($P < 0.05$) but not for male subjects. Poor glycemic control, defined as A1C ≥9.5%, as well as high LDL cholesterol and triglycerides were common among youth aged ≥15 years with either type of diabetes. Forty-four percent of youth with type 1 diabetes were overweight or obese.

CONCLUSIONS — Factors such as poor glycemic control, elevated lipids, and a high prevalence of overweight and obesity may put Hispanic youth with type 1 and type 2 diabetes at risk for future diabetes-related complications.

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In 2006, the U.S. Census Bureau estimated that there were 44.3 million people of Hispanic or Latino ethnicity living in the U.S., representing ~15% of the total U.S. population (1). About 66% of people of Hispanic ethnicity in the U.S. are Mexican American and 9% are Puerto Rican (2). About 2.5 million (9.5%) Hispanic Americans aged ≥20 years have been diagnosed with diabetes. Mexican Americans and residents of Puerto Rico are ~1.7 and 1.8 times as likely, respectively, to have diabetes as U.S. non-Hispanic whites of similar age (3).

In 2006, ~37% of the Hispanic population or 16 million youth were aged <20 years (2). Until recently, few large population-based studies about Hispanic youth with diabetes in the U.S. have been conducted, with the exception of diabetes registries in Colorado, Chicago, and Puerto Rico (4–6). The Colorado Type 1 Diabetes Registry reported incidence rates for type 1 diabetes from 1978 to 1988, the Chicago Childhood Diabetes Registry (CCDR) has reported on the incidence of type 1 and presumed type 2 diabetes since 1985, and the World Health Organization Diabetes Mondiale (DiaMond) study cohort includes youth from Puerto Rico diagnosed from 1985 to 1994 (4–6). The most recent estimates from Colorado are from a subset of the SEARCH for Diabetes in Youth Study (SEARCH study) sample (7). Other studies (8–11) of diabetes that have included Hispanic American youth have been conducted in Texas, Pennsylvania, California, and Florida.

The SEARCH study, a large population-based study of physician-diagnosed diabetes in youth aged <20 years in the U.S., estimated that in 2001 >17,600 Hispanic youth aged 0–19 years had diabetes (12). In this article, we report the prevalence and incidence of type 1 and type 2 diabetes and describe in detail selected demographic, clinical, and behavioral characteristics of Hispanic American youth with diabetes.

RESEARCH DESIGN AND METHODS

A detailed description of the SEARCH study methods has been published elsewhere (13). Briefly, the SEARCH study is a multicenter observational study that began conducting population-based ascertainment of cases of physician-diagnosed diabetes in youth aged <20 years beginning in 2001 and continuing through the present. Diabetic youth were identified in geographically defined populations in Ohio, Washington, South Carolina, and Colorado; managed health care plans in California and Hawaii; and four American Indian populations.

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The SEARCH study sought to identify all existing (prevalent) cases of diabetes in 2001 and all newly diagnosed (incident) cases in subsequent calendar years. Diabetes cases were considered valid if diagnosed by a physician. To identify 2001 prevalent cases, centers used databases and data sources that were sometimes common to all centers (e.g., hospital records) and sometimes unique to a specific center (e.g., A1C test results in laboratory databases) as well as direct case reports from health care providers, as previously described (12,13). Networks of health care providers are the primary source of identification of incident cases (13,14).

Data collection

Before implementation of the protocol, the local institutional review board(s) that had jurisdiction over the study population reviewed and approved the study protocol. Additionally, the study is compliant with Health Insurance Portability and Accountability Act regulations. All study personnel were trained and certified in study procedures before initiation of data collection and recertified annually. All survey instruments were translated into Spanish, and interviews were conducted in Spanish if that was the participant's preferred language.

Young adults (aged ≥18 years) with diabetes or the parent/guardian of youth aged <18 years were asked to complete a short initial survey that collected information on race and ethnicity and diabetes-related factors. All survey respondents, excluding those whose diabetes was secondary to other conditions, were invited to an in-person visit.

Written informed consent and assent were obtained according to local institutional review board guidelines. During this study visit, additional survey information was collected, including symptoms at presentation, medications, health care utilization, perceptions of care, and family history. Information about dietary intake, physical activity, and other health behaviors and depressive symptoms was collected from participants aged ≥10 years. Dietary intake was assessed by a food frequency instrument designed to capture regionally and culturally specific foods (15). Physical activity and smoking questions were derived from the Youth Risk Behavioral Surveillance System questionnaire, and depressive symptoms were assessed using the Center for Epidemiologic Studies-Depression Scale (CES-D) score (16–18). For youth aged ≥3 years, a brief physical examination included measurement of height, weight, waist circumference, and blood pressure and evaluation for acanthosis nigricans (13). Blood was drawn from metabolically stable participants (no episodes of diabetic ketoacidosis [DKA] during the previous month) after a minimum 8-h overnight fast. Nonfasting blood samples were obtained from participants that had not fasted or had not withheld their medications but agreed to give a blood sample.

Categorization of race and ethnicity

Race/ethnicity was based on self-report or medical record review in most cases and was collected using the 2000 U.S. Census questions (19). We categorized each participant to one of five race/ethnic categories (non-Hispanic white, Hispanic, African American, Asian/Pacific Islander, or American Indian). Individuals who reported Hispanic ethnicity were categorized as Hispanic ethnicity regardless of race. For the prevalence and incidence estimates, individuals with missing race and ethnicity were assigned fractionally to race and ethnicity categories based on the racial and ethnic composition of the zip code or census block where they resided. Fewer than 5% of youth in Hispanic prevalent and incident cohorts combined (n = 64) were categorized as Hispanic via this algorithm. Only youth of self-reported Hispanic ethnicity were included in the analyses of demographic and clinical characteristics, which included information collected at the time of the study visit.

We further categorized youth according to their Hispanic origin group (Mexican or Mexican American, Puerto Rican, Cuban, Dominican, Central American, South American, Spaniard, and other Hispanic) (1) using self-reported information based on the standard U.S. Census questions obtained on the initial participant survey (19). Youth who did not complete the initial survey were categorized as having no additional information for this descriptive analysis. Additionally, we reported the language in which the initial survey was administered, which was usually completed by a parent for youth with diabetes aged <18 years of age and by subjects with diabetes if they were aged ≥18 years.

Categorization of key variables

Diabetes type was reported by the health care professional or abstracted from medical records as type 1, type 1a, type 1b, type 2, maturity-onset diabetes of the young, hybrid, or other type. We have restricted our analyses to youth with type 1 (including type 1a and type 1b) or type 2 diabetes. We excluded from these analyses Hispanic youth whose type was reported as being other than type 1 or type 2 (n = 9) and those with missing diabetes type (n = 4).

We defined family history of diabetes as having a biological sibling, parent, or grandparent with diabetes (20). Acanthosis nigricans was reported as present or absent based on examination of the neck. Hypertension was defined as systolic and/or diastolic blood pressure ≥95th percentile for sex, age, and height (21). DKA at diagnosis (incident cases only) was considered present if a participant had at least one of the following noted in the medical record: *1*) blood bicarbonate <15 mmol/l or pH <7.25 (venous) or <7.30 (arterial or capillary), 2) ICD-9 code 250.1, or *3*) diagnosis of DKA mentioned in the medical record (22). Weight and height were compared with U.S. standards to calculate normalized *z*-scores (23). Youth with a BMI *z* score ≥95th percentile were considered obese, 85–94.9th percentiles overweight, ≥5th percentile to <85th percentile healthy weight, and <5th percentile were considered underweight (24). We included underweight youth in the healthy-weight category for these analyses due to the small number of underweight youth in our sample (11 type 1 and 0 type 2 diabetic subjects). C-peptide, triglycerides, and LDL cholesterol were reported for fasting blood samples only, while GAD65, A1C, HDL cholesterol, and apolipoprotein B (apoB) are reported for all samples, including those from nonfasting participants (13,25,26). ApoB was categorized as high if it was ≥90 mg/dl (27). A1C was categorized using the American Diabetes Association guidelines as good (<8.0%), marginal (8.0–9.4%), and poor (≥9.5%) (28). CES-D scores were considered high and indicative of moderately/severely depressed mood if they were ≥24 (29,30).

Analyses

Analyses include prevalent cases for 2001 and incident cases for years 2002–2005. The methods for estimating prevalence of diabetes for 2001 in the SEARCH study cohort have been previously reported (12). The prevalence of diabetes is expressed as cases per 1,000 youth using data pooled across all SEARCH study centers, with the 95% CI calculated by using an inverted score test from the binomial distribution (31). We present sex-specific data in four age categories (0–4, 5–9, 10–14, and 15–19 years) for type 1 diabetes and in two age categories (10–14 and 15–19 years) for type 2 diabetes. Prevalent cases of diabetes among youth aged <10 years were very rare and are reported in the text but not the figures.

The methods for estimating incidence rates were previously reported (14). We present incidence rates for Hispanics using incident diabetes cases over a 4-year period (2002–2005). Because the 2000 U.S. Census projections for youth residing in the participating areas were similar in 2002 and 2003 (−0.2% change overall), the 2002 denominator was multiplied by four and used as the total denominator for all cases ascertained during this period. We report sensitivity analyses exploring the possible impact of estimating the denominator in this manner. Aggregating data across 4 years allowed greater stability of the rate estimation within subgroups of age, sex, and diabetes type among the Hispanic youth. Incidence per 100,000 (10^5) person-years is reported with the 95% CI calculated by using an inverted-score test from the binomial distribution (31). To facilitate comparison of SEARCH study incidence rates with other studies, we reported the incidence of type 1 and type 2 diabetes for all youth and by sex for the subset of participants aged 0–17 years as well as the incidence rates of type 1 diabetes for all youth aged 0–14 years by sex using the World Health Organization DiaMond study methods for age adjustment (32,33).

All analyses were performed with SAS version 9.1 (SAS Institute, Cary, NC) and were stratified by diabetes type. Analyses of demographic and clinical characteristics of youth with diabetes combined youth whose diabetes was prevalent in 2001 with those whose diabetes was incident in 2002 through 2005. When applicable, linear or logistic regression was used to adjust for differences in diabetes duration between age categories for continuous and dichotomous outcomes, respectively. Statistical comparisons, except when otherwise noted, were made within diabetes type by age-group with male and female subjects combined. For selected variables, we compared youth with type 1 diabetes to those with type 2 diabetes. When results were missing, such as cases where results could only be reported for fasting blood samples, we performed an analysis of case subjects with complete data. Given the descriptive and hypothesis-generating nature of these analyses, we retained use of the traditional α of 0.05 to determine statistical significance despite the number of comparisons made.

RESULTS — The 2001 prevalent and 2002–2005 incident study cohorts included 1,416 Hispanic youth aged <20 years with type 1 or type 2 diabetes. The online appendix (available at http://care.diabetesjournals.org/cgi/content/full/32/Supplement_2/S123/DC1) has tables that include the numerators, denominators, and 95% CIs for the 2001 prevalence estimates and 2002–2005 incidence rates included in this report.

Prevalence of diabetes

From a population of 641,414 Hispanic youth, 781 had diabetes in 2001. Mexican or Mexican American youth comprised half of the sample (50%), while Puerto Rican (5%), Central American (3%), South American (2%), Cuban (1%), other Hispanic (14%), and youth with no additional information (25%) comprised the other half. For youth aged <10 years, 145 (99.3%) had type 1 diabetes and 1 (0.7%) had type 2 diabetes. Among youth aged 10–14 years, 242 (85.5%) had type 1 diabetes and 41 (14.5%) had type 2 diabetes, while among youth aged 15–19 years, 251 (71.3%) had type 1 diabetes and 101 (28.7%) had type 2 diabetes.

The prevalence of diabetes by diabetes type and age-group is shown in Fig. 1*A* and *B*. The one prevalent case of type 2 diabetes in a youth aged <10 years is excluded from these figures. For youth aged ≥10 years, the prevalence of type 1 diabetes exceeded type 2 diabetes for both sexes and age-groups (all $P < 0.0001$). We found no sex differences in the prevalence of type 1 or type 2 diabetes for any age-group.

Incidence of diabetes

The SEARCH study identified 635 Hispanic youth with diabetes incident in 2002–2005 from a population of 3,207,005 Hispanic person-years at risk. Mexican or Mexican American youth comprised over half of the sample (55%), with Puerto Rican (5%), Cuban (1%), Central American (2%), South American (2%), other Hispanics (15%), and youth with no information (20%) comprising the remainder of the sample. For youth aged <10 years, 234 (96.7%) had type 1 diabetes and 8 (3.3%) had type 2 diabetes. Among youth aged 10–14 years, 151 (62.1%) had type 1 diabetes and 92 (37.9%) had type 2 diabetes, while among youth aged 15–19 years, 63 (42.0%) had type 1 diabetes and 87 (58.0%) had type 2 diabetes.

The incidence (95% CI per 10^5) of type 1 diabetes for Hispanic youth aged 0–14 years was $15.0/10^5$ (12.9–17.3) for female subjects and $16.2/10^5$ (14.1–18.5) for male subjects. Among youth aged 0–17 years, the rates of type 1 diabetes were $14.1/10^5$ (12.3–16.2) for female subjects and $15.6/10^5$ (13.7–17.7) for male subjects. For type 2 diabetes, the rates were $6.9/10^5$ (5.7–8.4) and $4.8/10^5$ (3.8–6.0) for female and male subjects, respectively.

Type 2 diabetes was very rare in youth aged <10 years (eight incident cases) and is excluded from these figures. As shown in Fig. 1*C*, the incidence of type 1 diabetes peaked for female subjects at age 5–9 years and for male subjects at age 10–14 years. Figure 1*D* shows that in the 10- to 14-year age-group, the incidence of type 2 diabetes for female subjects was twice that of male subjects ($P < 0.005$). Among female subjects aged 15–19 years, the incidence of type 2 diabetes exceeded that of type 1 diabetes ($P < 0.05$). The incidence of type 1 and type 2 diabetes for male subjects aged 15–19 years was not significantly different.

Sensitivity analyses demonstrated that using the 2002 denominator multiplied by four was unlikely to result in any quantitatively meaningful bias, even if the true denominator changed by as much as 5% per year. Based on the current census reports, there is very little evidence that any racial/ethnic or other subgroup studied in the SEARCH study would have shown such a large change. If such a dramatic change did occur, the impact on the estimation of annual incidence rates (per 10^5) would be <1.0 to 3.0, for low ($<10/10^5$) or high ($35/10^5$) incidence rates, respectively.

Demographic and clinical characteristics

Of 678 Hispanic youth who completed the SEARCH study in-person visit, 551 had type 1 diabetes and 127 had type 2 diabetes (Table 1). The majority (65%) were Mexican or Mexican American. Family income and highest parental education did not differ by the participants' ages at the in-person visit within diabetes

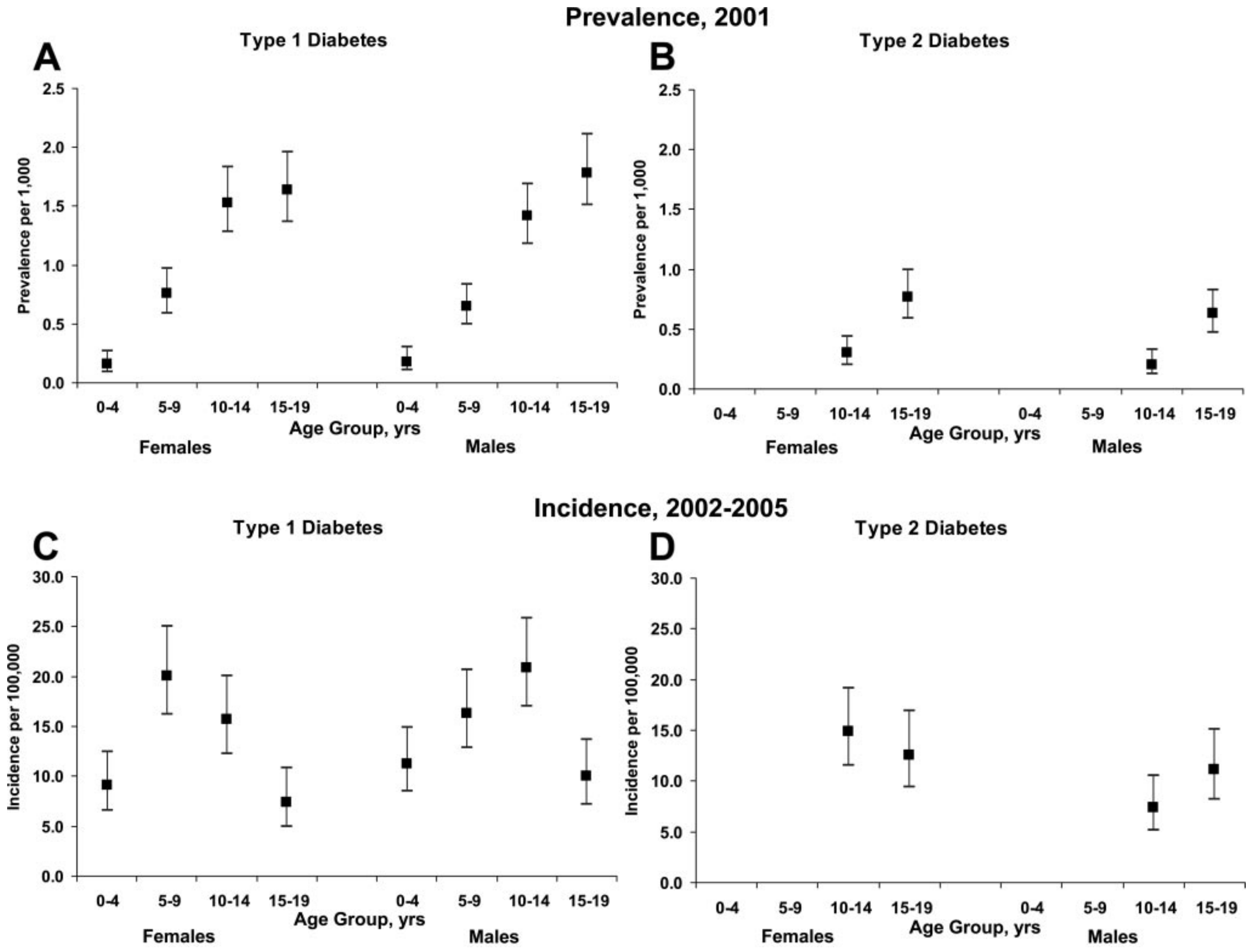

Figure 1—_2001 prevalence (A and B) and 2002–2005 incidence (C and D) of diabetes among Hispanic youth, by diabetes type, age-group, and sex._

type. Youth with type 2 diabetes came from families with a lower family income and lower parental education than did youth with type 1 diabetes (*P* value for each <0.001). Among youth with type 1 diabetes, residing in a one-parent household became more common with increasing age; 21% of youth aged <10 years resided in a one-parent household, while 39% of youth aged ≥15 years did ($P < 0.0001$). Household composition did not differ significantly by diabetes type. Type of health insurance did not differ significantly by age for youth with either type of diabetes. Seventy-two percent of youth completing the in-person visit reported having private health insurance.

Most youth with type 1 diabetes learned they had diabetes after experiencing symptoms, while diagnosis after symptoms and at a physical or check-up were both common for youth with type 2 diabetes (Table 2). Of the youth for whom we could assess DKA at diagnosis (247 for type 1 and 79 for type 2 diabetes), about one-quarter of youth with type 1 diabetes and <10% of youth with type 2 diabetes had DKA at diagnosis. Family history of diabetes was evident in over half of all Hispanic youth with either form of diabetes.

The distribution of BMI category (healthy weight, overweight, and obese) did not significantly differ by age category within diabetes type and sex groups. (Fig. 2). Among female subjects aged ≥15 years with type 1 diabetes, overweight appeared more commonly than healthy weight when compared with girls in the younger two age-groups, but the difference was not significant ($P = 0.06$). Of all youth with type 1 diabetes with measured BMI ($n = 488$), 215 (44%) were overweight or obese. As expected, the majority of youth with type 2 diabetes were obese.

Presence of acanthosis nigricans, a marker of insulin resistance, differed significantly by age-group among youth with type 1 diabetes but not for youth with type 2 diabetes. Among youth with type 1 diabetes, ~10% of youth aged 10–14 years and aged ≥15 years had acanthosis nigricans; only one child (0.7%) aged <10 years had acanthosis nigricans. Acanthosis nigricans affected two-thirds of youth aged 10–14 years and over half of youth aged ≥15 years who had type 2 diabetes. The proportion of youth with measured high blood pressure did not vary significantly by age for youth with type 1 or type 2 diabetes. Of the youth with type 2 diabetes, about half of those aged 10–14 years and less than one-third of those aged ≥15 years were on insulin or insulin and metformin.

Among Hispanic youth with a study visit, blood samples were available for ~80% of youth with type 1 diabetes (366 fasting and 72 nonfasting) and 88% of youth with type 2 diabetes (99 fasting and 13 nonfasting). Mean A1C increased with

Table 1—*Demographic characteristics of Hispanic youth with diabetes: the SEARCH study, 2001 prevalent and 2002–2005 incident cases with a study visit*

	Type 1 diabetes (n = 551)				Type 2 diabetes (n = 127)		
Age category (years)*	Aged 0–9 years	Aged 10–14 years	Aged ≥15 years	P†	Aged 10–14 years	Aged ≥15 years	P†
n	179	210	162		40	87	
Sex				0.76			0.23
Female	89 (49.7)	108 (51.4)	77 (47.5)		27 (67.5)	49 (56.3)	
Male	90 (50.3)	102 (48.6)	85 (52.5)		13 (32.5)	38 (43.7)	
Hispanic origin				0.61			0.28
Mexican American	112 (62.6)	139 (66.2)	100 (61.7)		27 (67.5)	62 (71.3)	
Puerto Rican	10 (5.6)	18 (8.6)	12 (7.4)		2 (5.0)	6 (6.9)	
Cuban	2 (1.1)	5 (2.4)	2 (1.2)		0	1 (1.2)	
South American	7 (3.9)	4 (1.9)	6 (3.7)		0	0	
Central American	5 (2.8)	3 (1.4)	7 (4.3)		0	5 (5.8)	
Spaniard	2 (1.1)	0	2 (1.2)		0	1 (1.2)	
Other Hispanic	41 (22.9)	41 (19.5)	33 (20.4)		11 (27.5)	12 (13.8)	
Language for initial survey				0.029			0.84
English	157 (87.7)	169 (80.5)	145 (89.5)		31 (77.5)	66 (75.9)	
Spanish	22 (12.3)	41 (19.5)	17 (10.5)		9 (22.5)	21 (24.4)	
Family income category				0.86			0.50
<$25,000	30 (18.9)	41 (21.0)	26 (19.5)		15 (44.1)	22 (31.9)	
$25,000–$49,000	52 (32.7)	70 (35.9)	47 (35.3)		11 (32.4)	27 (39.1)	
$50,000–$74,000	32 (20.1)	43 (22.1)	27 (20.3)		2 (5.9)	9 (13.0)	
≥$75,000	45 (28.3)	41 (21.0)	33 (24.8)		6 (17.6)	11 (15.9)	
Highest parental education				0.40			0.87
Less than high school	25 (14)	37 (17.8)	30 (18.9)		13 (32.5)	24 (27.9)	
High school graduate	46 (25.7)	45 (21.6)	28 (17.6)		10 (25)	23 (26.7)	
More than high school	108 (60.3)	126 (60.6)	101 (63.5)		17 (42.5)	39 (45.3)	
Household composition				<0.0001			0.19
Two parents/one household	133 (74.3)	129 (61.7)	72 (44.7)		22 (55.0)	51 (58.6)	
One-parent household	38 (21.2)	64 (30.6)	63 (39.1)		16 (40.0)	24 (27.6)	
Other composition	8 (4.5)	16 (7.7)	26 (16.1)		2 (5.0)	12 (13.8)	
Type of health insurance				0.12			0.29
Private‡	131 (73.2)	156 (74.3)	120 (74.5)		23 (57.5)	60 (69.8)	
Medicaid/ low income	44 (24.6)	45 (21.4)	28 (17.4)		14 (35.0)	17 (19.8)	
Other	2 (1.1)	5 (2.4)	4 (2.5)		0	1 (1.2)	
None	2 (1.1)	4 (1.9)	9 (5.6)		3 (7.5)	8 (9.3)	

Data are n (%). *Age at time of in-person visit. †P value using χ^2 test for the association between variable levels and age-groups. When results were missing, descriptive information and P values are based on participants with complete data. ‡A total of 55.5% of the Hispanic youth were members of managed health care plans in California and Hawaii at the time of case ascertainment, although insurance status may have changed by the time of the SEARCH study in-person study visit when these demographic data were collected.

increasing age category for youth with type 1 ($P < 0.001$) and type 2 ($P < 0.01$) diabetes and was attenuated when adjusted for duration of diabetes ($P < 0.05$ for each). The proportion of youth with poor glycemic control was highest for youth aged ≥15 years with type 1 or type 2 diabetes; over one-third of youth in this age category were in poor control (A1C ≥9.5%). Of youth with type 1 diabetes, 58% in the youngest age category and 59% of youth aged ≥10 years were positive for GAD65, whereas 16% of youth aged 10–14 years and 19% of youth aged ≥15 years with type 2 diabetes were positive for GAD65 antibodies. After adjustment for diabetes duration, mean fasting C-peptide values increased with age category for youth with type 1 diabetes ($P < 0.0001$). Fasting C-peptide did not differ by age category for youth with type 2 diabetes and was significantly higher among youth with type 1 diabetes. For the youth with type 1 diabetes, the proportion with high triglycerides, low HDL cholesterol, and elevated apoB increased with increasing age category (all $P < 0.005$). Of youth aged ≥15 years, 34% of those with type 1 diabetes had elevated triglycerides and 22% had low HDL cholesterol compared with 72 and 55% of youth with type 2 diabetes, respectively.

We examined several psychosocial and behavioral characteristics (Table 3). Of youth with type 1 diabetes, ~6% of those aged 10–14 years and 14% of those aged ≥15 years had a CES-D score exceeding the threshold for moderately or severely depressed mood ($P < 0.05$). Of youth with type 2 diabetes, 18% of those aged 10–14 years and almost 20% of those aged ≥15 years exceeded this threshold, with no significant differences observed by sex. For youth aged 10–14 years, those with type 2 diabetes were

Table 2—*Clinical characteristics and laboratory results for 678 Hispanic youth with type 1 or type 2 diabetes: the SEARCH study, 2001 prevalent and 2002–2005 incident cohorts with a study visit*

	Type 1 diabetes (n = 551)				Type 2 diabetes (n = 127)		
	Aged 0–9 years*	Aged 10–14 years	Aged ≥15 years	P†	Aged 10–14 years	Aged ≥15 years	P†
n	179	210	162		40	87	
Diagnosis							
Age at diabetes diagnosis (years) (means ± SD)	4.5 ± 2.5	8.7 ± 3.2	11.2 ± 4.2	NA	11.6 ± 1.5	14.6 ± 2.1	NA
Duration of diabetes at visit (months) (means ± SD)	22.0 ± 22.9	41.4 ± 38.0	73.2 ± 50.8	<0.0001	13.8 ± 10.7	26.8 ± 24.0	0.001
Duration of diabetes at visit (months) [*n* (%)]				<0.0001			0.014
<6	37 (20.8)	21 (10.0)	7 (4.3)		8 (20.0)	9 (10.3)	
6–12	47 (26.4)	35 (16.7)	13 (8.1)		12 (30.0)	19 (21.8)	
>12	94 (52.8)	154 (73.3)	141 (97.6)		20 (50.0)	59 (67.8)	
Learned they had diabetes through the following [*n* (%)]‡				NA			NA
Symptoms	159 (90.9)	189 (92.6)	141 (88.1)		20 (51.3)	39 (47.6)	
Physical/check up	12 (7.4)	17 (9.2)	21 (14.1)		12 (31.6)	29 (35.4)	
Screening	4 (2.5)	5 (2.7)	3 (2.0)		2 (5.3)	5 (6.3)	
DKA at diagnosis, incident cases [*n* (% yes)]	30 (25.6)	22 (23.7)	8 (21.6)	0.87	3 (9.4)	3 (6.4)	0.62
Any family history of diabetes [*n* (% yes)]§	92 (52.3)	129 (62.0)	113 (70.2)	0.003	35 (89.7)	71 (82.6)	0.30
Clinical characteristics							
BMI (means ± SD)	17.6 ± 2.7	21.7 ± 3.9	25.5 ± 5.1	<0.0001	32.0 ± 8.1	33.3 ± 7.4	0.42
BMI *z* score (means ± SD)	0.7 ± 1.0	0.8 ± 0.9	0.8 ± 1.1	0.29	2 ± 0.9	1.8 ± 0.8	0.28
Acanthosis nigricans [*n* (% present)]	1 (0.7)	20 (10.4)	16 (10.7)	0.0009	24 (66.7)	46 (56.1)	0.28
High blood pressure at visit [*n* (%)]‖	15 (10.8)	12 (6.2)	6 (4.0)	0.07	7 (18.9)	18 (21.7)	0.73
High blood pressure adjusted for duration (%)	11.6	6.3	3.6	0.07	20.4	20.6	0.98
Diabetes medications [*n* (%)]				<0.0001			0.038
Currently on insulin only	178 (100.0)	207 (99.0)	142 (88.8)		13 (37.1)	12 (16.0)	
Currently on insulin and metformin	0	2 (1.0)	12 (7.5)		4 (11.4)	9 (12.0)	
Currently on metformin only	0	0	6 (3.8)		17 (48.6)	42 (56.0)	
No diabetes medication	0	0	0		1 (2.9)	12 (16.0)	
Laboratory measurements							
(%) (means ± SD)	8.0 (1.2)	8.6 (1.9)	8.9 (2.0)	0.0002	7.1 (2.2)	8.5 (2.6)	0.009
Adjusted for duration (means ± SE)	8.2 (0.2)	8.6 (0.1)	8.7 (0.2)	0.042	7.3 (0.4)	8.4 (0.3)	0.043
Glycemic control [*n* (%)]¶				0.0002			0.023
Good (A1C < 8.0%)	64 (51.6)	75 (42.1)	48 (34.8)		26 (74.3)	37 (46.8)	
Marginal (8.0 ≤ A1C < 9.5%)	45 (36.3)	48 (27.0)	40 (29.0)		4 (11.4)	15 (19.0)	
Poor (A1C ≥ 9.5%)	15 (12.1)	55 (30.9)	50 (36.2)		5 (14.3)	27 (34.2)	
GAD65 positive [*n* (% yes)]	68 (58.1)	102 (59.3)	80 (59.3)	0.98	5 (16.1)	14 (19.2)	0.71
Adjusted for duration (%)	52.7	58.1	66.3	0.15	18.2	17.5	0.93
Fasting C-peptide (means ± SD)	0.4 (0.3)	0.6 (0.7)	0.6 (0.9)	0.06	4.4 (2.4)	3.9 (2.6)	0.35
Mean fasting C-peptide adjusted for duration (means ± SE)	0.3 (0.1)	0.6 (0.1)	0.8 (0.1)	<0.0001	4.2 (0.5)	4 (0.3)	0.69
LDL cholesterol (mg/dl) (means ± SD)	96.6 ± 22.5	96.2 ± 26.8	99.7 ± 26.1	0.51	104.4 ± 28.8	108.3 ± 3.5	0.59
Adjusted for duration (means ± SE)	98.9 ± 2.6	97.1 ± 2.0	96.9 ± 2.5	0.83	105.8 ± 6.0	107.7 ± 4.1	0.80
High LDL cholesterol (≥100 mg/dl) [*n* (% yes)]	42 (41.2)	58 (38.2)	58 (51.8)	0.078	18 (56.3)	38 (56.7)	0.97
Adjusted for duration (% yes)	43.5	39.0	48.8	0.33	57.4	56.2	0.91
Triglycerides (mg/dl) (geometric means ± SD)	50.1 ± 1.4	65.4 ± 1.6	91.4 ± 1.9	<0.0001	127.7 ± 1.7	159.9 ± 2.0	0.10
Adjusted for duration (geometric mean ± SE)	51.5 ± 1.1	66 ± 1.0	88.9 ± 1.1	<0.0001	128.1 ± 1.1	159.7 ± 1.1	0.13
High triglycerides (≥110 mg/dl) [*n* (% yes)]	3 (2.9)	21 (13.8)	38 (33.9)	<0.0001	19 (59.4)	48 (71.6)	0.22
Adjusted for duration (% yes)	3.2	14.1	30.9	<0.0001	60.8	71.2	0.32
HDL cholesterol (mg/dl) (means ± SD)	55.3 ± 11.7	54 ± 11.7	50.1 ± 14.1	0.002	41.6 ± 8.6	40.5 ± 10.4	0.61
Adjusted for duration (means ± SE)	56.1 ± 1.2	54.2 ± 0.9	49.1 ± 1.1	0.0001	42.4 ± 1.7	40.2 ± 1.1	0.29
Low HDL cholesterol (≤40 mg/dl) [*n* (% yes)]	9 (7.4)	24 (13.5)	30 (21.7)	0.004	17 (50.0)	43 (55.1)	0.62
Adjusted for duration (% yes)	6.3	12.7	24.7	0.0006	47.5	56.2	0.41
Apolipoprotein B [median (interquartile range)]	70.0 (15.0)	70.0 (29.0)	80.0 (40.0)	0.008	84.0 (30)	97.5 (41.0)	0.45
Adjusted for duration [median (interquartile range)]	69.2 (4.4)	70.5 (5.3)	77.8 (7.3)	0.20	88.5 (1.6)	92.9 (4.7)	0.66
High apolipoprotein B (≥90 mg/dl) [*n* (%)]	11 (14.5)	27 (19.7)	44 (35.8)	<0.0001	10 (47.6)	38 (61.3)	0.27
Adjusted for duration (% yes)	16.1	20.2	33.1	0.021	53.2	60.3	0.59

*Age at time of in-person visit. †*P* value for categorical variables using χ^2 test for the association between variable levels and age-groups. *P* value for continuous variables using ANOVA for the overall effect of age-group. *P* value for adjusted variables using logistic regression (categorical variables) or linear regression (continuous variables) for the overall effect of age-group. When results were missing, descriptive information and *P* values are based on participants with complete data. ‡More than one response category allowed. §Family history includes parents, grandparents, and biological siblings with any form of diabetes. ‖High blood pressure defined as measured blood pressure (systolic or diastolic) ≥ age-, sex-, and height-specific 95th percentile. ¶Glycemic control categories based on American Diabetes Association recommendations.

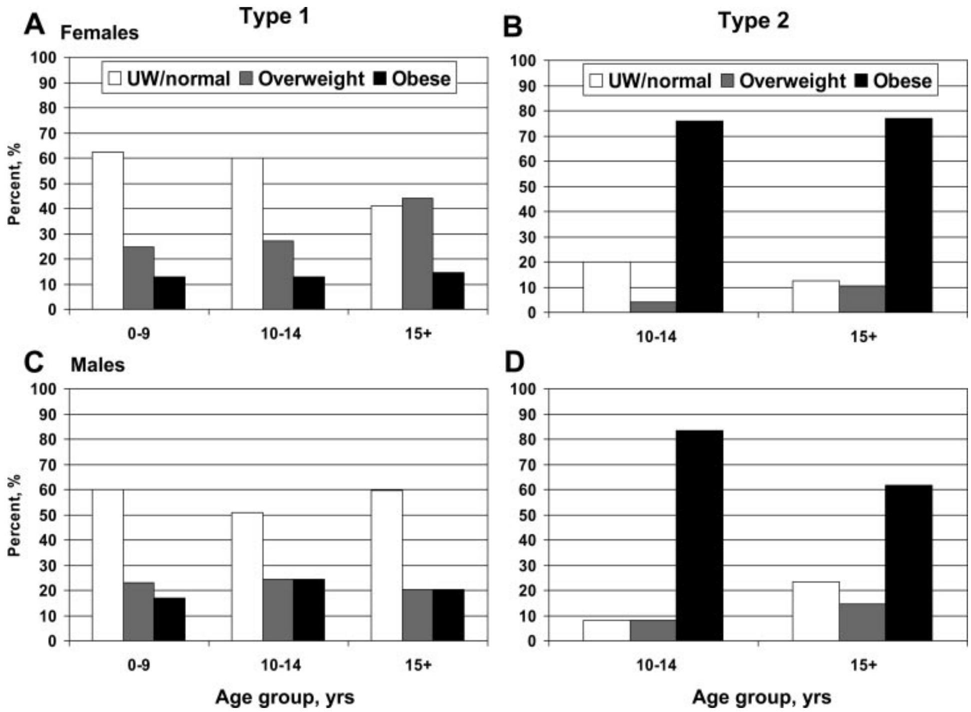

Figure 2—*Overweight and obesity among Hispanic 2001 prevalent and 2002–2005 incident cohorts of youth with diabetes, by diabetes type, age-group, and sex* (A *and* B*: Female subjects;* C *and* D*: Male subjects).*

more likely to have moderately/severely depressed mood than youth with type 1 diabetes ($P < 0.05$), but there was no difference by diabetes type for youth aged ≥15 years. Of youth aged ≥15 years, 14% of youth with type 1 diabetes and 13% of youth with type 2 diabetes were cigarette smokers at the time of the interview.

Both moderate to vigorous physical activity at least 3 days a week and television watching for at least 2 h a day were common and were not significantly associated with age category for youth with either type of diabetes. For youth with type 1 diabetes, only number of servings of dairy per day varied significantly by age, with youth aged 10–14 years reporting two servings and those aged ≥15 years reporting 1.6 servings ($P < 0.005$). There were no differences by age for youth with type 2 diabetes. The dietary requirements for the intake of fruits and vegetables and dairy were not met by the majority of respondents. Almost all of the youth exceeded 7% of kcal from saturated fat.

CONCLUSIONS— In a population of predominantly Mexican American Hispanic youth, including youth aged 10–19 years, type 1 diabetes was the most prevalent type of diabetes. There were no significant sex differences in the prevalence of type 1 or type 2 diabetes for any age-group. However, for Hispanic female subjects aged 15–19 years, the incidence of type 2 diabetes exceeded that of type 1 diabetes. We observed that the incidence of type 1 diabetes peaked at age 5–9 years for female subjects. In other U.S. studies, including the CCDR (34) and the 1978–1988 data from the Colorado type 1 diabetes registry (7), the incidence peaked at age 10–14 years for female subjects. However, a study of diabetes incidence in Castilla-Leon Spain reported that the incidence peaked at age 5–9 years for both male and female subjects, although their reported incidence of $40.4/10^5$ (95% CI 27.4–53.4) for female subjects aged 5–9 years was twice that of the SEARCH study incidence, whereas the incidence for girls aged 10–14 years, $15.7/10^5$ (8.2–23.2), was quite similar to the SEARCH study (35).

To our knowledge, there are no other estimates of type- and sex-specific prevalence of diabetes among Hispanic youth in the U.S. Estimates of the incidence of type 1 diabetes in U.S. Hispanic youth aged 0–14 years have been reported as $18.0/10^5$ (95% CI 17.6–18.3) in Puerto Rico for 1985–1994 (6), $1.5/10^5$ (0.7–2.9) in Veracruz Mexico for 1990–1993 (33), and $15.5/10^5$ (5.6–23.7) in Philadelphia for 1995–1999 (36). The incidence rates for type 1 diabetes among Hispanic youth aged 0–14 years in the SEARCH study ($15.0/10^5$ for female subjects and $16.2/10^5$ for male subjects) are lower than the rate from Puerto Rico, similar to the rate from the Philadelphia cohort, but much higher than that reported from Mexico. Significant variation in the incidence of type 1 diabetes in Latin American countries has previously been reported by the DiaMond project (33).

The CCDR reported that the incidence of type 1 diabetes in Hispanic youth was $9.8/10^5$ (95% CI 7.6–12.7) for female subjects and $10.6/10^5$ (8.3–13.5) for male subjects aged 0–17 years for 1999–2003 (34). In the SEARCH study, the incidence of type 1 diabetes in this age-group for 2002–2005 ($14.1/10^5$ for female subjects and $15.6/10^5$ for male subjects) was higher than that from the CCDR for both male and female subjects. The incidence of presumptive type 2 diabetes, defined by the CCDR as having a "type 2–like course" (going without insulin after the honeymoon period, obesity at diagnosis, acanthosis nigricans, or polycystic ovary syndrome) was $7.2/10^5$ (5.0–10.4) for female subjects and $5.9/10^5$ (4.1–8.4) for male subjects (34). This was quite similar to the rates of type 2 diabetes reported by the SEARCH study for female subjects ($6.9/10^5$ [5.7–8.4]) and slightly higher than that reported by the SEARCH study for male subjects ($4.8/10^5$ [3.8–6.0]).

Table 3—*Psychosocial, behavioral, and dietary characteristics of 499 Hispanic youth aged ≥10 years with type 1 or type 2 diabetes: the SEARCH study, 2001 prevalent and 2002–2005 incident cohorts with a study visit*

	Type 1 diabetes (*n* = 372)			Type 2 diabetes (*n* = 127)		
	Aged 10–14 years*	Aged ≥15 years	*P*†	Aged 10–14 years	Aged ≥15 years	*P*†
n	210	162		40	87	
Psychosocial						
CES-D score (means ± SD)	10.8 ± 7.0	12.9 ± 9.9	0.017	14.9 ± 9.6	14.9 ± 11.0	0.99
High CES-D score (≥24) [*n* (% yes)]‡	12 (6.1)	21 (13.8)	0.014	6 (17.6)	16 (19.5)	0.82
Behavioral						
Current smoker [*n* (% yes)]	2 (1.0)	22 (14.3)	<0.0001	0	11 (12.9)	0.03
Physical activity measures						
Three to seven days/week moderate or vigorous [*n* (% yes)]	124 (62.0)	85 (54.8)	0.17	20 (57.1)	47 (55.3)	0.85
Watching television ≥2 h/day [*n* (% yes)]	129 (64.5)	100 (64.5)	0.99	23 (65.7)	64 (75.3)	0.29
Dietary intake						
Percent total kcal from total fat (mean kcal ± SD)	37.3 ± 6.0	38.5 ± 7.1	0.15	39.1 ± 6.1	36.3 ± 7.4	0.08
≥7% of kcal from saturated fat [*n* (% yes)]	161 (100.0)	126 (99.2)	0.26	29 (100.0)	67 (100.0)	NA
Number of servings of fruit and vegetables per day (mean servings ± SD)	3.3 ± 3.2	3 ± 2.2	0.53	3 ± 2.3	3 ± 2.3	0.92
Less than five servings per day of fruit and vegetables [*n* (% yes)]	136 (84.5)	106 (83.5)	0.82	25 (86.2)	55 (82.1)	0.62
Number of servings of dairy per day (mean servings ± SD)	2 ± 1.4	1.6 ± 1.2	0.011	1.6 ± 1.4	1.4 ± 1.0	0.50
Less than two servings per day of dairy [*n* (% yes)]	97 (60.2)	85 (66.9)	0.24	18 (62.1)	50 (74.6)	0.21

*Age at time of in-person visit. †*P* value for categorical variables using χ^2 test for the association between variable levels and age-groups. *P* value for continuous variables using ANOVA for the overall effect of age-group. When results were missing, descriptive information and *P* values are based on participants with complete data. ‡Value is indicative of moderately/severely depressed mood (17,18).

The observation that type 1 diabetes remains the predominant form of diabetes in Hispanic youth made by the CCDR is consistent with the observations made by the SEARCH study. Similarly, 82% (59 of 72) of the Hispanic youth in a Florida cohort of youth with diabetes aged 5–19 years had type 1 diabetes (9). In contrast, Hale et al. (8) reported that the incidence of type 2 diabetes exceeded that of type 1 diabetes from 1996 to 1998, based on their cohort of 329 Mexican American youth aged 0–17 years diagnosed from 1990 to 1998 in a sole pediatric diabetes practice in south Texas. Their classification of diabetes type was based on clinical presentation, family history, physical examination, clinical course, and response to therapeutic agents (8), while the SEARCH study classified diabetes type based on the physician report at the time of case referral (14).

Overweight and obesity were common in Hispanic youth with diabetes. While this was not surprising for youth with type 2 diabetes, we also observed that among youth with type 1 diabetes 44% were overweight or obese. Lipton et al. (37) reported that 13.2% of Hispanic youth with type 1 diabetes had obesity noted in their medical record in the 1985–1990 CCDR cohort. The higher prevalence of obesity in the SEARCH study than in the earlier CCDR cohort might be expected since the prevalence of obesity has tended to increase over time. Data from the National Health and Nutrition Examination Survey 1999–2002 showed that 39.9% of Mexican American youth aged 6–19 years were overweight or obese, exceeding the overweight/obesity of both non-Hispanic white and African American youth (38).

The high level of poor glycemic control (over a third of the youth were in poor control), as well as the elevated prevalence of dyslipidemia (high LDL cholesterol, high triglycerides, and elevated apoB among youth in the oldest age-group), are causes for concern. Poor glycemic control puts individuals with diabetes at increased risk for diabetes complications later in life (39,40), and dyslipidemia is a cardiovascular risk marker. The SEARCH study has previously reported that higher A1C is associated with dyslipidemia in youth with type 1 and type 2 diabetes (41). In the U.S., ~43% of Hispanic youth aged <19 years have private health insurance, which is lower than what we found in the SEARCH study (42). However, over half of Hispanic youth in the SEARCH study were recruited from two health plan–based centers (California and Hawaii), so this high level of health insurance coverage may be a function of case sources and was not unexpected.

About 70% of youth aged <20 years of Hispanic ethnicity in the U.S. are Mexican American and 8% are Puerto Rican (2). Among SEARCH study visit participants (a subset of the 2001 prevalent and 2002–2005 incident diabetes groups combined) ~65% (*n* = 440) were Mexican American, 7% (*n* = 48) were Puerto Rican, and 20% (*n* = 138) were unspecified. While Hispanic youth in the SEARCH study, recruited predominantly from California and Colorado, are fairly consistent in proportion with the two largest Hispanic groups in the U.S., it should be mentioned that Hispanic youth with diabetes from other U.S. regions with large Hispanic populations may have a somewhat different distribution of Hispanic-origin groups.

These analyses have several limitations. Our reliance on the 2002 estimates for the denominator is due to the complexity in estimating age- and race/ethnicity-specific noninstitutionalized, nonmilitary population denominators for the geographic centers. However, our sensitivity analysis suggested that this was not likely to significantly bias our rates. Additionally, analyses include information from the initial research visit only and thus are cross-sectional, so we are unable to examine factors such as the clinical course of diabetes. Follow-up data collection is underway to address these issues. Furthermore, a substantial proportion of youth did not participate in the research visit despite significant efforts to increase participation rates. In an analysis of response rates among the 2001–2004 SEARCH study cohorts, we found that among Hispanic youth, 36% of youth whose diabetes was prevalent in 2001 and 52% of youth whose diabetes was incident in 2002–2004 participated in the research visit. Participation by Hispanic children and youth did not differ significantly from that of non-Hispanic white youth after adjustment for age, diabetes type, sex, and diabetes duration for either the prevalent or incident cohorts (43). Nonetheless, the SEARCH study is one of the largest and most comprehensive studies of diabetes in Hispanic youth with extensive clinical, demographic, and biochemical data ($n = 678$); the inclusion of youth with type 1 and type 2 diabetes using a common study protocol; the diverse geographic regions from which the respondents were drawn; and our ability to describe Hispanic subgroups for the majority of the participants using standardized census categories.

Our data present strong evidence that Hispanic American youth experience a substantial health burden due to type 1 diabetes; type 2 diabetes, although present, is less common than type 1 diabetes in this age and ethnic group. Sex-specific estimates demonstrate that the incidence of type 2 diabetes for female subjects aged 10–14 years is twice that of male subjects, and, for female subjects aged 15–19 years, the incidence of type 2 diabetes exceeds that of type 1 diabetes. Thus, for Hispanic girls entering their early childbearing years, type 2 diabetes is as common as type 1 diabetes. Access to and utilization of preconception care to reduce the risk of diabetes-related pregnancy complications will be essential for these young women (44). Being overweight or obese was common not only in youth with type 2 diabetes but also in youth with type 1 diabetes. Over one-third of Hispanic youth aged ≥15 years with type 1 or type 2 diabetes had poor glycemic control, a risk factor for future diabetes-related complications. The SEARCH study and other studies should continue to assess the epidemiology as well as the clinical, behavioral, and psychosocial characteristics of Hispanic youth with diabetes to inform public health initiatives and health care policy and to plan for appropriate pediatric health care resources for Hispanic communities. Research focusing on improvements in weight status, metabolic control, and dyslipidemia among Hispanic youth with type 1 or type 2 diabetes is urgently needed.

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