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Glycemic Control in Youth with Diabetes: The SEARCH for Diabetes in Youth Study

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Abstract

Objective—To assess correlates of glycemic control in a diverse population of children and youth with diabetes.

Study design—This was a cross-sectional analysis of data from a 6-center US study of diabetes in youth, including 3947 individuals with type 1 diabetes (T1D) and 552 with type 2 diabetes (T2D), using hemoglobin A_{1c} (HbA_{1c}) levels to assess glycemic control.

Results—HbA_{1c} levels reflecting poor glycemic control ($HbA_{1c} \geq 9.5\%$) were found in 17% of youth with T1D and in 27% of those with T2D. African-American, American Indian, Hispanic, and Asian/Pacific Islander youth with T1D were significantly more likely to have higher HbA_{1c} levels compared with non-Hispanic white youth (with respective rates for poor glycemic control of 36%, 52%, 27%, and 26% vs 12%). Similarly poor control in these 4 racial/ethnic groups was

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*A complete list of the members of the SEARCH for Diabetes in Youth Study Group is available at www.jpeds.com (Appendix 1).

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found in youth with T2D. Longer duration of diabetes was significantly asso*ciated with poorer glycemic control in youth with T1D and T2D.

Conclusions—The high percentage of US youth with HbA_{1c} levels above the target value and with poor glycemic control indicates an urgent need for effective treatment strategies to improve metabolic status in youth with diabetes.

Intensive glycemic control prevents the development or delays the progression of microvascular complications of diabetes in adults with type 1 diabetes (T1D) and type 2 diabetes (T2D)[1,2] and in adolescents with T1D.[3] Lower HbA_{1c} levels also reduce the risk of macrovascular disease in patients with T1D,[4] although recent results for patients with T2D are equivocal.[5–7]

In the Swedish Childhood Diabetes Registry (adjusted to the Diabetes Control and Complications Trial standard), for more than 3000 patients age < 20 years, the average hemoglobin A_{1c} (HbA_{1c}) value was < 8% in 35% of the patients and > 9% in 29%.[8] Correlates of relatively high HbA_{1c} included female sex, older age, longer duration of diabetes, and high insulin dose. This type of descriptive data from large, unselected cohorts of youth with diabetes is critical to identifying groups of patients who may benefit from targeted interventions to improve metabolic control and thus reduce risk for long-term complications of diabetes. The SEARCH for Diabetes in Youth Study is a large observational study of childhood diabetes that includes a highly diverse population of youth with T1D and T2D. In the present work, we investigated the prevalence and correlates of good, intermediate, and poor glycemic control, measured using HbA_{1c}.

Methods

The SEARCH for Diabetes in Youth Study is ongoing at 6 study centers in the United States, with the goal of describing the epidemiology of childhood diabetes according to race/ethnicity, age, sex, and diabetes type. The study design has been published previously.[9] It involves identifying existing (prevalent) cases of non-gestational diabetes in patients under age 20 years in 2001 and newly diagnosed (incident) cases in subsequent calendar years, with the goal of complete case ascertainment in each population under surveillance by the 6 study centers. The institutional review boards for all 6 sites approved the study protocol, and all activities are HIPAA-compliant. Prevalence for 2001[10] and incidence rates for 2002–2003 have been published,[11] with estimated case ascertainment completeness exceeding 90%.

The present analysis includes the 2001 prevalent and 2002–2005 incident study cohort participants with a clinical diagnosis of either T1D or T2D, as determined by each participant's health care provider. Data were collected for these cohorts between 2002 and 2007. Concerted efforts were made to contact each of the 11 179 patients with diabetes identified by the study in 2001–2005 whose diabetes was not secondary to other conditions to solicit their participation in an initial survey to collect information on age at diagnosis and race/ethnicity. The individuals who completed this survey were then asked to participate in an in-person research clinic visit that included blood sampling for HbA_{1c} and other measures, a brief physical examination (including height and weight measurements), and an

interview dealing with socio-demographic factors and health issues. At the time of the study visit, informed consent was obtained from each participant age 18 or older and from the parent/guardian of any participant age 17 or younger. All measures were conducted by trained, certified staff in accordance with standardized study protocols (available at www.searchfordiabetes.org). HbA_{1c} was measured in whole blood with an automated non-porous ion-exchange high-performance liquid chromatography system (model G-7; Tosoh Bioscience, Montgomeryville, Pennsylvania). This method has demonstrated to be linear from a total area of 500 to > 4500, indicating that the results are accurate within a large range of number of red cells. If the total area is < 500, then results are not reported; if the total area is > 4500, then the analysis is repeated after sample dilution. The intrassay coefficient of variation is 0.047%, the interassay coefficient of variation is 0.070%, and the normal reference range values are 4.2% to 5.8%.[9] Ultimately, 5299 (47%) of the 2001–2005 cases attended the research clinic visit. Not all of these individuals agreed to the blood draw; a total of 4499 individuals (3947 with T1D and 552 with T2D) had complete data and contributed data to the analysis. GAD65 was positive in 53.6% of the youth with T1D and in 18.9% of those with T2D, similar to previously reported data from SEARCH.[11]

Variable Definition

American Diabetes Association (ADA) target values for HbA_{1c} in relation to age are as follows: 7.5% to 8.5% at age < 6 years, < 8.0% at age 6 to 12 years, < 7.5% at age 13 to 18 years, and < 7.0% at age 19+ years.[12,13] Individuals who met the ADA target (or for age < 6 years, who had an HbA_{1c} < 8.5%) were classified as “good” control; those with $HbA_{1c} \geq$ 9.5% regardless of age were classified as “poor” control, and those with HbA1c values between the definition of “good” and “poor” control were classified as “intermediate” control. HbA_{1c} also was used in its continuous (uncategorized) form for statistical testing.

Height and weight measurements were used to calculate body mass index (BMI; in kg/m^2). Age- and sex-specific BMI *z*-scores were derived from the Centers for Disease Control and Prevention (CDC) national standards, and the following weight status categories were assigned: “underweight or normal weight” for individuals < 85th percentile, “overweight” for those in the 85th to 95th percentiles, and “obese” for those > 95th percentile.[14] Self-reported race and ethnicity were collected using 2000 US Census questions. All participants who reported “Hispanic” ethnicity were categorized as “Hispanic,” regardless of race. Among non-Hispanics, those who reported more than one race were placed into a single race category using the plurality approach of the National Center for Health Statistics.[15]

Parental education was defined as the highest educational level attained by either parent. Insurance source was categorized as “none,” “private” (including private only or private plus something else), “Medicaid or Medicare,” and “other.” The latter category included Indian Health Service, military, school-based, and any other source not in combination with either private insurance or Medicaid/Medicare.

Statistical Analysis

All analyses were conducted using a single measure of HbA_{1c}, collected at the study examination. Key characteristics that can possibly affect glycemic control, including

underlying etiology, age at diagnosis, and diabetes treatment regimen, differ dramatically between youth with T1D and those with T2D. Because the intent of the present study was not to compare and contrast characteristics between diabetes types, but rather to describe glycemic control in youth with diabetes, analyses were conducted after stratification by diabetes type.

Subject characteristics were described using counts and percentages, stratified by diabetes type. Univariate associations between the subject characteristics and glycemic control (HbA_{1c}) were tested for statistical significance using 1-way analysis of variance stratified by diabetes type. The *P* values for these associations were based on HbA_{1c} as a continuous outcome, because this approach has greater statistical power.

Separate multivariate linear regression models (stratified by diabetes type) were used to evaluate the associations between each of the following subject characteristics and HbA_{1c} after adjusting for all other listed characteristics: age at study examination, duration of diabetes, weight status, family structure, diabetes care provider, race/ethnicity, sex, household income, parental education, and insurance source.

Although many statistical tests were conducted, because the present work was intended to be descriptive and hypothesis-generating in nature, the traditional *P* value < .05 (2-tailed test) was considered statistically significant. No formal correction was made for multiple tests. All statistical analyses were conducted using SAS for Windows version 9.1 (SAS Institute, Cary, North Carolina).

Results

The overall mean HbA_{1c} value was 8.18% ± 1.59% for youth with T1D and 7.99% ± 2.51% for youth with T2D. Overall, 17% of the youth with T1D and 27% of those with T2D had poor glycemic control (ie, $HbA_{1c} \geq 9.5\%$) (Table I; available at www.jpeds.com). For both T1D and T2D, the percentage of youth above the age-specific target HbA_{1c} was higher with increasing age at the time of the SEARCH examination. In those age 19+ years, 29% of those with T1D and 47% of those with T2D exhibited poor glycemic control.

In univariate comparisons for T1D, glycemic control (ie, HbA_{1c}) was significantly associated with all of the characteristics except weight status (Table I). After adjustment for age at the study examination, duration of diabetes, weight status, family structure, diabetes care provider, race/ethnicity, sex, household income, parental education, and insurance source, most patterns of association and statistical significance remained as observed in the unadjusted models. Multivariate results are presented in Table II (available at www.jpeds.com). Exceptions were weight status, which became statistically significant, and insurance source and household income, which were no longer statistically significant in the multivariate regression model. The statistically significant correlates of poorer glycemic control in the multivariate model for T1D were younger age, longer diabetes duration, weight <85th percentile (vs being obese), living in a single-parent household or other household structure (vs living in a 2-parent household), type of diabetes care provider (adult

endocrinologist or none vs pediatric endocrinologist), race/ethnicity other than non-Hispanic white, being female, and lower parental education (Table II).

Among participants with T2D, the descriptive univariate findings (Table I) revealed worse glycemic control in those with older age, longer duration of diabetes, normal-weight/underweight or overweight status, “other” household structure (vs 2-parent or single-parent household), race/ethnicity other than non-Hispanic white, parental education less than high school or bachelor’s degree or more, and no or “other” health insurance, whereas those cared for by a pediatric endocrinologist had better glycemic control. In the multivariate results (Table II), patterns of association were generally similar, although only duration of diabetes and parental education were statistically significant.

Discussion

A high proportion of children and youth with diabetes in this study exhibited poor HbA_{1c} values. This finding is particularly disturbing given that almost all of the youth were insured and all were motivated to volunteer for research.

Our finding of poor glycemic control in youth with T1D is similar to published data from other countries.[8,16] In these countries, there were center variations in glycemic control that were not explained by demographic or clinical factors. It has been suggested that a more detailed exploration of then implementation of treatment regimens may be informative.[16] In a separate report from SEARCH, youth with T1D who used insulin pumps had lower HbA_{1c} values and fewer acute complications compared with those on other insulin regimens.[17]

The pattern of worsening glycemic control with increasing duration of T1D, independent of many other potential correlates, likely is due in part to progressive loss of beta cell function.[18] The difficulty of maintaining motivation for the intensive daily diabetes care patterns and lifestyle changes required to achieve glycemic targets likely is a contributing factor. Worse glycemic control in normal or underweight youth with T1D compared with their obese counterparts has not been reported previously, and reasons for this finding are unknown. The poorer residual beta cell function in youth with T1D with lower BMI[18] may play a role. Females had significantly worse glycemic control than males (Table II), although from a clinical perspective, the difference in HbA_{1c} between the sexes was small (0.10).

Studies of children and youth with diabetes generally report a constellation of related sociodemographic factors associated with glycemic control, including race/ethnicity, socioeconomic status, parental education, parental involvement in diabetes management, and family dynamics. In the present study, African-American, Hispanic, American Indian, and Asian/Pacific Islander youth all had poorer glycemic control than non-Hispanic whites even after adjustment for all other variables studied. Comparing African-American and Caucasian children with T1D, Chalew et al[19] also reported higher mean HbA_{1c} levels in the African-American children independent of sex, insurance status, BMI, and number of clinic visits. In contrast, however, Gallegos-Macias et al[20] reported that the higher HbA_{1c} values seen in Hispanic youth with T1D compared with non-Hispanic white youth with T1D were

accounted for by lower socioeconomic status irrespective of race/ethnicity. Indeed, in the present study, lower parental education level and living in a single-parent or other family structure were associated independently with worse glycemic control. These factors may act either directly or indirectly through their influence on adherence to recommended selfcare.[19–24]

In univariate analyses, uninsured youth with T1D had poorer glycemic control, although after adjustment for other characteristics, this association was no longer statistically significant, perhaps due to the small number of youth with diabetes who were without insurance. Despite the fact that virtually all patients with T1D were insured, lower income was marginally associated with worse HbA_{1c} values, even after adjusting for parental education, race/ethnicity, and clinical characteristics. Unmeasured financial impacts of insurance benefit structure—uncovered out-of-pocket expenses, copayments, and lost wages—affect families with various incomes differently, which might explain our observation. Low and modest income also may affect the ability of youth and their families to manage diabetes for reasons other than the monetary costs of health care, possibly including impaired access to diabetes care providers. Indeed, receiving diabetes care from a pediatric endocrinologist or diabetologist was associated independently with better glycemic control. Economic and other barriers to care will be the topic of further study in the SEARCH cohort. Improved understanding of the social mediators of the association between sociodemographic characteristics and glycemic control could assist in the development of tailored treatment strategies that might make it possible for patients and families to better adhere to diabetes care regimens and to attain their target HbA_{1c} goals more easily.

Patterns of the correlates of glycemic control were generally similar for youth with T2D and those with T1D. But in the multivariate analyses, only duration of diabetes and attained parental education were statistically significant, likely due, at least in part, to lower statistical power given the substantially smaller number of subjects with T2D (n = 552) compared with those with T1D (n = 3947). Rothman et al[25] reported that among adolescents with T2D, after adjustment for a several demographic and clinical factors, HbA_{1c} values were higher in their non-Caucasian subjects than in their Caucasian subjects. The present analysis adjusted for 2 variables that may partly account for that racial/ethnic disparity in glycemic control that were not assessed in the study of Rothman et al[25]—parental education and family structure—which may explain why in the present analysis, race/ethnicity was not statistically significantly associated with glycemic control. Results for educational attainment were somewhat unexpected, in that after adjustment for other factors, youth with T2D whose highest parental educational level was less than high school appeared to have comparable glycemic control with those with at least one parent with a bachelor's degree or higher, and better glycemic control was observed for those with intermediate levels of parental education. It may be that small sample size, particularly for the highest education grouping, generated a spurious result. As for youth with T1D, further study of the sociodemographic factors that affect the glycemic control of youth with T2D is needed. In addition, it is possible that the underlying genetic and biological factors that contribute variously to the etiology of diabetes (whether T1D or T2D) also may affect the relative ease or difficulty of meeting HbA_{1c} targets. Such speculation should be the target of future investigations.

Limitations of the present study include the selective nature of the SEARCH centers and nonparticipation in the study visit at which blood is drawn, which might limit the generalizability of our results. The potential impact of nonresponse[9] on the present analysis was evaluated using routine clinical laboratory HbA1c test results from one of the study centers with institutional review board–approved access to clinical results for all patients who would be eligible to participate in the SEARCH study protocol. At this center, 1209 of the 1390 youth with diabetes in the 2001 and 2002 SEARCH study cohorts (87%) underwent HbA1c testing as part of their clinical care. For the youth in the 2001 prevalent cohort, the mean HbA1c was significantly lower in those who attended the study visit compared with those who did not (8.9% ± 1.9% vs 9.5% ± 2.4%), although for youth in the 2002 incident cohort, the results did not differ (9.5% ± 2.5% vs 9.4% ± 2.4%). Thus, our findings may underestimate the proportion of youth with diabetes in poor glycemic control.

Our HbA_{1c} analyzer is linear over the large red blood cell range (total area, 500 to > 4500); however, we cannot exclude the possibility that a few individuals had aberrant results due to glycation, hemoglobin variants, and/or red cell life span.[26] We did not measure hematocrit or look for hemglobin variants; however, in persons with impaired glucose tolerance, adjustment for hematocrit and other factors likely to affect glycemiv control do not account for race/ethnic differences in HbA_{1c}.[27] The most common cause of an aberrant value (albeit still rare) would be sickle cell anemia in the African-American subgroup,[28] in which red cell survival is decreased, resulting in lower HbA_{1c} values than would be expected in relation to average blood glucose concentrations.

Strengths of the present study include its sample size, although despite the inclusion of > 500 youth with T2D, the limited variability in some characteristics may have limited the study's statistical power to detect potential clinically important differences in this T2D subgroup. Additional study strengths include the ethnic and geographic diversity and the use of a single laboratory to measure HbA_{1c}.

Our data highlight the need for strategies to improve glycemic control in youth with diabetes. Technologies for managing diabetes continue to evolve.[29,30] Continuous glucose monitoring can now be used in conjunction with insulin pumps and traditional glucose monitoring by fingerstick to optimize glycemic control throughout the day. As with any diabetes care regimen, the financial and social burden on the patient and his or her family to maintain good metabolic control is substantial. Results from the Diabetes Control and Complications Trial indicate that glycemic control in participants on the intensive treatment arm was improved significantly by the consistent use of a nutrition plan relative to insulin dose.[31] Physical activity is another key determinant of glucose excursions and must be considered in optimal insulin dosing.[32]

Particular challenges arise when attempting to develop comprehensive diabetes management strategies that adequately address the complexity of diabetes care during adolescence, as physiological, emotional, and social development is unfolding. Recent successful interventions designed specifically for adolescents have used motivational interviewing[33] and behavioral family systems therapy for diabetes.[34] Further research is urgently needed to establish interventions that meld efficacious technology with effective behavioral and social

approaches to improve glycemic control for the highly diverse group of youth living with diabetes.

Glossary

BMI	Body mass index
HbA1c	Glycated hemoglobin
T1D	Type 1 diabetes
T2D	Type 2 diabetes

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Appendix 1

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Appendix 2

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Table I

Percentage of individuals with T1D or T2D with good, intermediate, or poor glycemic control according to clinical and demographic characteristics: SEARCH for Diabetes in Youth, prevalent 2001 and incident 2002–2005 study participants

	T1D (n = 3947)					T2D (n = 552)				
		Glycemic control, %*					Glycemic control, %*			
Characteristic	**N**	**Good**	**Intermediate**	**Poor**	***P*†**	**n**	**Good**	**Intermediate**	**Poor**	***P*†**
All	3947	44.4	38.8	16.8		552	53.8	19.6	26.6	
Age at diagnosis, years					<.0001					.1529
0–5	1185	44.8	40.1	15.1		0	—	—	—	
6–12	2065	43.6	38.9	17.5		182	58.2	17.6	24.2	
13–18	693	45.7	36.7	17.6		360	51.9	20.8	27.2	
19+	4	75.0	0.0	25.0		10	40.0	10.0	50.0	
Age at examination, years					<.0001					<.0001
0–5	402	66.9	25.1	8.0		0	—	—	—	
6–12	1748	54.1	34.7	11.3		77	72.7	11.7	15.6	
13–18	1499	32.4	44.4	23.3		369	57.5	19.5	23.0	
19+	298	17.8	53.7	28.5		106	27.4	25.5	47.2	
Diabetes duration, months					<.0001					<.0001
< 12	1167	69.4	23.1	7.5		183	71.0	16.4	12.6	
12–23	827	47.8	37.1	15.1		164	56.7	20.1	23.2	
24–47	581	38.9	43.0	18.1		113	44.3	19.5	36.3	
48+	1369	23.5	51.3	25.3		92	26.1	25.0	48.9	
Weight status‡					.2712					.0002
Underweight or normal weight (<85th percentile)	2654	44.4	39.0	16.6		67	43.3	11.9	44.8	
Overweight (85th to 94th percentile)	808	41.8	40.5	17.7		69	46.4	21.7	31.9	
Obese (> 95th percentile)	485	48.7	35.1	16.3		416	56.7	20.4	22.8	
Family structure					<.0001					.0088
Two-parent household	2623	50.1	37.7	12.2		224	52.2	20.1	27.7	
Single-parent household	1126	33.9	41.5	24.6		238	59.7	18.9	21.4	
Other household structure	177	26.0	38.4	35.6		57	43.9	21.1	35.1	
Diabetes care provider					<.0001					<.0001

Characteristic	T1D (n = 3947) N	Glycemic control, %* Good	Intermediate	Poor	P†	T2D (n = 552) n	Glycemic control, %* Good	Intermediate	Poor	P†
Pediatric endocrinologist or diabetologist	2995	45.5	39.0	15.4		309	65.4	17.2	17.5	
Adult endocrinologist	151	18.5	45.7	35.8		31	41.9	12.9	45.2	
General pediatrician, family physician, or general internist	146	28.8	41.1	30.1		91	33.0	25.3	41.8	
Nurse practitioner or physician assistant	552	50.7	34.6	14.7		40	55.0	20.0	25.0	
Other/don’t know	75	36.0	42.7	21.3		37	40.5	29.7	29.7	
None, no medical care	8	25.0	37.5	37.5		12	16.7	16.7	66.7	
Race/ethnicity					<.0001					<.0001
Non-Hispanic white	2983	46.9	40.8	12.3		107	71.0	16.8	12.2	
African American	355	34.7	29.9	35.5		175	58.9	18.9	22.3	
Hispanic	440	39.1	33.6	27.3		117	50.4	22.2	27.4	
Asian/Pacific Islander	127	37.0	37.0	26.0		44	47.7	15.9	36.4	
American Indian	23	17.4	30.4	52.2		105	34.3	21.9	43.8	
Sex					.0040					.1610
Female	1961	42.9	39.2	17.9		350	50.3	21.4	28.3	
Male	1986	45.8	38.4	15.8		202	59.9	16.3	23.8	
Household income					<.0001					.6613
<$25 K	495	35.6	34.3	30.1		201	57.2	20.4	22.4	
$25–49 K	848	40.6	39.2	20.3		129	53.5	24.8	21.7	
$50–74 K	793	46.0	40.9	13.1		56	64.3	8.9	26.8	
$75 + K	1500	50.9	39.5	9.6		48	66.7	10.4	22.9	
Parental education					<.0001					.0160
Less than high school	160	34.4	28.1	37.5		87	46.0	18.4	35.6	
High school graduate or GED	618	35.8	38.0	26.2		172	61.1	19.2	19.8	
Some college (but less than bachelor’s degree)	1296	41.3	40.1	18.6		164	55.5	22.0	22.6	
Bachelor’s degree or more	1843	50.5	39.1	10.4		89	50.6	16.9	32.6	
Insurance					<.0001					.0013
None	59	28.8	30.5	40.7		21	28.6	28.6	42.9	
Private	3127	46.5	39.8	13.7		266	57.9	16.9	25.2	
Medicaid/Medicare	666	36.3	35.1	28.5		191	56.5	22.5	20.9	

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Characteristic	T1D (n = 3947) N	Glycemic control, %* Good	Intermediate	Poor	P†	T2D (n = 552) n	Glycemic control, %* Good	Intermediate	Poor	P†
Other§	69	42.0	36.2	21.7		40	35.0	20.0	45.0	

*Glycemic control defined as “good” used age-specific HbA_{1c} target values as follows: < 6 years, <8.5%; 6 to 12 years, <8.0%; 13 to 18 years, <7.5%; 19+ years, <7.0%. “Poor” glycemic control was defined as $HbA_{1c} \geq 9.5\%$. “Intermediate” glycemic control was defined as values between “good” and “poor.”

†*P* values are based on analysis of variance, treating HbA_{1c} as a continuous outcome and testing the association with each covariate individually.

‡Weight status defined based on CDC guidelines using age- and sex-specific BMI percentiles (Ref).

§Includes Indian Health Service, military, school-based, and other (when these are not in combination with either private insurance or Medicaid/Medicare).

Table II

Associations of HbA_{1c} with clinical and demographic characteristics (adjusted): SEARCH for Diabetes in Youth, prevalent 2001 and incident 2002–2005 study participants

	T1D (n = 3606)			T2D (n = 421)		
Characteristic	**Estimate**	**95% CI**	***P*** *	**Estimate**	**95% CI**	***P*** *
Age at examination, years			<.0001			.1470
0–5	Ref	—	—	—	—	—
6–12	−0.33	−0.49 to −0.16	<.0001	0.66	−1.60 to 0.28	.1679
13–18	−0.15	−0.32 to 0.03	.0956	−0.75	−1.50 to 0.00	.0515
19+	−0.56	−0.84 to −0.28	<.0001	Ref	—	—
Diabetes duration, months			<.0001			.0058
< 12	Ref	—	—	Ref	—	—
12–23	0.67	0.54 to 0.80	<.0001	0.41	−0.14 to 0.96	.1417
24–47	0.89	0.74 to 1.03	<.0001	0.72	0.08 to 1.36	.0286
48+	1.18	1.05 to 1.30	<.0001	1.38	0.60 to 2.17	.0006
Weight status†			.0018			.2378
Underweight or normal weight (< 85th percentile)	0.19	0.05 to 0.34	.0096	0.57	−0.15 to 1.29	.1231
Overweight (85th to 94th percentile)	0.02	−0.15 to 0.19	.8255	0.33	−0.36 to 1.02	.3447
Obese (> 95th percentile)	Ref	—	—	Ref	—	—
Family structure			.0003			.1866
Two-parent household	Ref	—	—	Ref	—	—
Single-parent household	0.19	0.08 to 0.30	.0011	−0.42	−0.91 to 0.07	.0896
Other household structure	0.39	0.14 to 0.65	.0024	0.01	−0.80 to 0.83	.9746
Diabetes care provider			.0049			.1218
Pediatric endocrinologist or diabetologist	Ref	—	—	Ref	—	—
Adult endocrinologist	0.41	0.10 to 0.72	.0090	0.34	−0.79 to 1.47	.5517
General pediatrician or family physician or general internist	0.21	−0.05 to 0.47	.1069	0.49	−0.32 to 1.30	.2346
Nurse practitioner or physician assistant	−0.06	−0.19 to 0.07	.3831	0.78	−0.01 to 1.56	.0530
Other/don’t know	−0.07	−0.42 to 0.29	.7130	−0.12	−1.19 to 0.95	.8221
None, no medical care	1.48	0.41 to 2.54	.0068	1.96	0.18 to 3.75	.0310
Race/ethnicity			<.0001			.1322

Characteristic	T1D (n = 3606)			T2D (n = 421)		
	Estimate	95% CI	*P* *	Estimate	95% CI	*P* *
Non-Hispanic white	Ref	—	—	Ref	—	—
African American	0.69	0.52 to 0.87	<.0001	0.52	−0.09 to 1.14	.0959
Hispanic	0.25	0.09 to 0.40	.0025	0.47	−0.19 to 1.13	.1652
Asian/Pacific Islander	0.41	0.14 to 0.67	.0027	0.90	0.03 to 1.77	.0418
American Indian	1.02	0.34 to 1.71	.0034	1.16	0.10 to 2.21	.0327
Sex			.0277			.7680
Female	0.10	0.01 to 0.20	.0277	0.07	−0.38 to 0.52	.7680
Male	Ref	—	—	Ref	—	—
Household income			.0597			.4847
<$25 K	Ref	—	—	Ref	—	—
$25–49 K	−0.13	−0.31 to 0.04	.1323	−0.04	−0.61 to 0.52	.8813
$50–74 K	−0.22	−0.42 to −0.02	.0328	0.17	−0.61 to 0.96	.6622
$75 + K	−0.27	−0.47 to −0.07	.0081	−0.53	−1.42 to 0.36	.2434
Parental education			<.0001			.0447
Less than high school	0.40	0.12 to 0.68	.0052	−0.07	−0.90 to 0.77	.8694
High school graduate or GED	0.35	0.19 to 0.50	<.0001	−0.75	−1.43 to −0.07	.0300
Some college (but less than bachelor's degree)	0.26	0.15 to 0.38	<.0001	−0.64	−1.30 to 0.01	.0554
Bachelor's degree or more	Ref	—	—	Ref	—	—
Insurance			.2499			.8844
None	0.38	−0.04 to 0.79	.0763	0.20	−1.12 to 1.53	.7617
Private	Ref	—	—	Ref	—	—
Medicaid/Medicare	0.03	−0.13 to 0.20	.6946	−0.18	−0.75 to 0.39	.5347
Other‡	−0.17	−0.54 to 0.20	.3720	−0.25	−1.42 to 0.92	.6760

*Each characteristic was adjusted for all other variables shown in the table, with HbA_{1c} treated as a continuous outcome (n = 3606 for the type 1 adjusted model and n = 421 for the type 2 adjusted model).

†Weight status defined based on CDC guidelines using age- and sex-specific BMI percentiles (Ref).

‡Includes Indian Health Service, military, school-based, and other (when these are not in combination with either private insurance or Medicaid/Medicare).