Obesity in Youth with Type 1 Diabetes in Germany, Austria, and the United States

Stephanie N. DuBose, MPH, Julia M. Hermann, MS, William V. Tamborlane, MD, Roy W. Beck, MD, PhD, Axel Dost, MD, Linda A. DiMeglio, MD, MPH, Karl Otfried Schwab, MD, Reinhard W. Holl, MD, Sabine E. Hofer, MD, PhD, and David M. Maahs, MD, PhD, on behalf of the Type 1 Diabetes Exchange Clinic Network and Diabetes Prospective Follow-up Registry.

Objective To examine the current extent of the obesity problem in 2 large pediatric clinical registries in the US and Europe and to examine the hypotheses that increased body mass index (BMI) z-scores (BMIz) are associated with greater hemoglobin A1c (HbA1c) and increased frequency of severe hypoglycemia in youth with type 1 diabetes (T1D).

Study design International (World Health Organization) and national (Centers for Disease Control and Prevention/ German Health Interview and Examination Survey for Children and Adolescents) BMI references were used to calculate BMIz in participants (age 2–<18 years and ≥1 year duration of T1D) enrolled in the T1D Exchange (n = 11 435) and the Diabetes Prospective Follow-up (n = 21 501). Associations between BMIz and HbA1c and severe hypoglycemia were assessed.

Results Participants in both registries had median BMI values that were greater than international and their respective national reference values. BMIz was significantly greater in the T1D Exchange vs the Diabetes Prospective Follow-up (P < .001). After stratification by age-group, no differences in BMI between registries existed for children 2–5 years, but differences were confirmed for 6–to 9-, 10– to 13-, and 14– to 17-year age groups (all P < .001). Greater BMIz were significantly related to greater HbA1c levels and more frequent occurrence of severe hypoglycemia across the registries, although these associations may not be clinically relevant.

Conclusions Excessive weight is a common problem in children with T1D in Germany and Austria and, especially, in the US. Our data suggest that obesity contributes to the challenges in achieving optimal glycemic control in children and adolescents with T1D. (J Pediatr 2015; ■: ■: ■.)
methods

The T1DX Clinic Network includes 70 US-based pediatric and adult endocrinology practices in 34 states. A registry of more than 26,000 individuals with T1D commenced enrollment in September 2010. Each clinic received approval from a local institutional review board (IRB). Informed consent was obtained according to IRB requirements. Data were collected for the registry’s central database from the participant’s medical record and by having the participant or parent complete a comprehensive questionnaire, as previously described.

The DPV registry is a prospective longitudinal, standardized, and computer-based documentation system for patients with all types of diabetes. Currently, more than 90% of German and more than 70% of Austrian children with diabetes are included in the registry. Data are documented locally by the 391 participating centers in an electronic health record. Twice yearly, anonymized data are exported and transmitted for central analyses. Missing and inconsistent data are reported back to the centers for correction. Data collection is approved by the ethics committee at Ulm University and by the IRBs at the participating centers.

This report includes data on 32,936 children 2 to <18 years of age with a T1D duration of at least 1 year and available height and weight data; 11,435 participants enrolled in the T1DX from September 2010 to August 2012 at 59 sites who care for pediatric patients and 21,501 patients from 262 sites in the DPV who had at least one office visit in either 2011 or 2012. All eligible T1DX and DPV participants were included in this analysis. Median HbA1c over the year before the registry assessment, calculated from all available for the previous year but excluding any values obtained within 3 months of diagnosis, was used to represent HbA1c in this analysis. For both the T1DX and DPV, all HbA1c values were DCCT-standardized.

Severe hypoglycemia was defined by both registries as a hypoglycemic event in which seizure or loss of consciousness occurred. The numbers given correspond to the percent of patients with at least one severe hypoglycemia event during the previous year. BMI percentiles and z-scores were calculated from height and weight and adjusted for age and sex, using both international (World Health Organization [WHO]) and national [Centers for Disease Control and Prevention [CDC] for T1DX and German Health Interview and Examination Survey for Children and Adolescents [KiGGS] for DPV) reference tables. Extreme BMIZ (BMIz < -3 and >+3) were truncated. In the WHO and the national reference populations, a BMIz of 0 represents the mean value of the population; values above the mean are positive and values below the mean are negative. BMI categories were defined using BMIz according to pediatric standards for each source.

Underweight individuals were excluded from analyses that assessed glucose control, because underweight status in adolescents with T1D often is caused by eating disorders, and psychiatric disorders have a strong impact on HbA1c and severe hypoglycemia.

In the T1DX, data were obtained through a combination of clinic and participant-report. Method of insulin delivery (pump/injection), height, weight, HbA1c values, and frequency of severe hypoglycemia were extracted retrospectively from the medical chart. Rates of self-monitoring of blood glucose and insulin dose were obtained from participant report via completion of a questionnaire. Conversely, all data from the DPV were extracted from the electronic medical record, as documented by members of the local diabetes team during routine patient care. All data from T1DX were obtained at the enrollment visit and data from DPV were collected from office visits that occurred during 2011 or 2012 (a similar time period as T1DX enrollment).

Statistical Analyses

To compare BMI between the 2 registries, a mixed model was used with BMIz calculated from the WHO reference tables. The model accounted for site differences and adjusted for T1D duration, sex, age group, and the interaction between registry and age group. Mixed models also were used to assess whether BMI was associated with HbA1c or severe hypoglycemia, overall (WHO reference and adjusted for T1D duration, sex, age group, registry, and random site effect) and within each registry (CDC or KiGGS reference and adjusted for T1D duration, sex, age group, and random site effect). Tests of significance were reported from models using BMIz as a continuous variable; adjusted means were reported from models using BMI as a categorical variable. Underweight individuals (based on corresponding cutoffs for underweight categorization) were excluded from these analyses. Although BMIz adjusts an individual BMI value for age and sex of the reference population, these factors were not fully adjusted for in our population and thus were included in the statistical models to account for residual confounding that could be present in this analysis cohort. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, North Carolina). All P values are 2-sided. A priori, in view of the large sample size and multiple comparisons, only P values <.01 were considered statistically significant.

Results

Participant characteristics of children in the T1DX and DPV registries can be found in Table I. Children in both registries were similar with respect to sex, total daily insulin dose per
kilogram, and frequency of severe hypoglycemia, but a greater percentage of children in T1DX were using an insulin pump (56% vs 45%). Children in T1DX also had a greater mean HbA1c level (8.5% vs 7.9%) than those in DPV.

Children in both registries had an increased BMI compared with international reference values (unadjusted median BMIz 0.78 for T1DX and 0.65 for DPV) and their respective national reference values (unadjusted median BMIz 0.74 for T1DX and 0.33 for DPV) (Table I). Overall, by the WHO, 12% (n = 3977) of children in both registries combined were considered obese, 24% (n = 7825) overweight, 64% (n = 20 942) normal weight, and <1% (n = 192) underweight (Table II).

When comparing BMIz between the registries using WHO reference tables, BMI was significantly greater in T1DX than in DPV (P < .001; Table I). Differences in least squares mean BMIz by age group are shown in Figure 1, adjusted for T1D duration, sex, age group, and the interaction between registry and age group. No significant difference in BMIz was found in the 2- to <6-year-old group (P = .10), but children in T1DX had greater BMIz than DPV children in all other age groups (P < .001 for all).

Overall, greater BMIz (WHO) was associated with greater HbA1c, adjusted for T1D duration, sex, age group, and registry (P < .001; Figure 2, A). When we looked at the registry-specific BMIz (CDC or KiGGS), greater BMI also was associated with

<table>
<thead>
<tr>
<th>Table I. Participant characteristics of T1DX and DPV</th>
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<tbody>
<tr>
<td>Overall, N = 32 936</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Male, %</td>
</tr>
<tr>
<td>Age (years), median (25th, 75th percentile)</td>
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<tr>
<td>T1D duration (years), median (25th, 75th percentile)</td>
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<tr>
<td>BMIz (WHO) (years), median (25th, 75th percentile)</td>
</tr>
<tr>
<td>BMIz (CDC and KiGGS) (years), median (25th, 75th percentile)</td>
</tr>
<tr>
<td>Insulin pump use, %</td>
</tr>
<tr>
<td>HbA1c, %, mean ± SD, mmol/mol</td>
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<tr>
<td>Frequency of self-monitoring of blood glucose, median (25th, 75th percentile)</td>
</tr>
<tr>
<td>Total daily insulin dose (units/kg body weight), median (25th, 75th percentile)</td>
</tr>
<tr>
<td>Percent prandial insulin, median (25th, 75th percentile)</td>
</tr>
<tr>
<td>≥1 Severe hypoglycemic event* in past 12 months, %</td>
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</tbody>
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N/A not applicable.
Data shown are unadjusted percentages, mean ± SD, or median and IQR (25th, 75th percentile).
*Resulting in seizure/loss of consciousness.

<table>
<thead>
<tr>
<th>Table II. BMI categories* overall and by registry, according to each reference table</th>
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<tbody>
<tr>
<td>Overall, N = 32 936</td>
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<tr>
<td>---------------------</td>
</tr>
<tr>
<td>WHO reference</td>
</tr>
<tr>
<td>Underweight, n (%)</td>
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<tr>
<td>Normal weight, n (%)</td>
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<tr>
<td>Overweight, n (%)</td>
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<tr>
<td>Obese, n (%)</td>
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<tr>
<td>CDC reference</td>
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<tr>
<td>Underweight, n (%)</td>
</tr>
<tr>
<td>Normal weight, n (%)</td>
</tr>
<tr>
<td>Overweight, n (%)</td>
</tr>
<tr>
<td>Obese, n (%)</td>
</tr>
<tr>
<td>KiGGS reference</td>
</tr>
<tr>
<td>Underweight, n (%)</td>
</tr>
<tr>
<td>Normal weight, n (%)</td>
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<tr>
<td>Overweight, n (%)</td>
</tr>
<tr>
<td>Obese, n (%)</td>
</tr>
</tbody>
</table>

*BMI categories defined as follows:


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greater HbA1c within each registry ($P < .001$ for both, adjusted for T1D duration, sex, and age group). Similarly, greater BMIz (WHO) was associated with increased frequency of at least one severe hypoglycemia event in the past year, adjusted for T1D duration, sex, age group, and registry ($P < .001$, Figure 2, B).

However, when we examined registry-specific BMIz (CDC or KiGGS), greater BMIz was significantly associated with severe hypoglycemia within DPV ($P = .004$) but only marginally within T1DX ($P = .05$).

**Discussion**

In contrast to historic experience, our data demonstrate that youth with T1D have increased BMIz compared with the international norms developed by the WHO and the respective national norms for youth in the US and in Germany/Austria. These data extend the findings of recent reports from the DCCT/EDIC study to highlight the consistency of increased BMI in Western countries in which intensive management of T1D is standard of care.5 Of particular concern, our cross-sectional data also demonstrate that greater weight in youth with T1D may be inversely associated with achieving the goals of intensive treatment, because increased BMIz was associated with greater HbA1c in both registries. This relationship between HbA1c and BMI was not found by Redondo et al.,28 but those authors assessed a cohort of newly diagnosed patients with T1D, whereas our report was limited to participants with at least 1 year T1D duration (mean duration 4.8 ± 3.5 years). Increased BMIz was associated with a greater risk of severe hypoglycemia in the DPV cohort, but an association between BMI and severe hypoglycemia was not found in the T1DX registry. These differences in HbA1c and severe hypoglycemia between BMI groups, however, were small and may not be clinically relevant. Further, the cause-effect relationship of the association between severe hypoglycemia and BMI is uncertain.

Compared with international WHO BMI standards, youth in the T1DX were more obese than youth in the DPV, except in the 2- to <6-year old group. It is likely that the differences in lifestyle and nutrition that contribute to increased rates of obesity in children without diabetes in the US compared with Europe also contribute to the different prevalence of overweight and obesity in youth with T1D. Whether differences in nutritional counseling and carbohydrate counting recommendations for patients with T1D between US and Europe also contribute to these trans-Atlantic differences in BMI remains to be determined.

Healthy weight is an important component of care for youth with T1D but how to achieve this goal while maintaining glucose and HbA1c levels as close to normal as possible with intensive insulin therapy has not been established. Greater attention to avoidance of excessive caloric intake and better food choices early in the treatment of T1D, encouragement of regular physical activity, reduced screen time, and the elimination of unnecessary snacks are among the factors that could play roles in achieving and maintaining healthy weights in this population. Given the challenges of preventing and treating obesity in youth with T1D who receive intensive treatment, adjunctive therapies to insulin, like metformin, glucagon-like peptide 1 agonists and sodium-glucose cotransporter-2 inhibitors that have been shown to lower HbA1c and body weight in adults with...
T2D, could be important additions to current options for care in youth with T1D.29,30

Recent studies indicate that the benefits of limiting excessive weight gain in children and adolescents with T1D extend beyond improvements in body image and psychosocial well-being to include a reduction in insulin resistance and cardiovascular risk factors. Insulin resistance is increased in youth with T1D compared with youth without diabetes of similar age, sex, and BMIz, especially in children who fail to achieve target HbA1c levels.31,32 As insulin resistance increases so do cardiovascular disease risk factors.33 Similarly, data from the DCCT/EDIC study in adults with T1D indicate that excessive weight gain is associated with insulin resistance, hypertension, dyslipidemia, central obesity, and more extensive atherosclerosis (as assessed by coronary artery calcium and carotid intima media thickness).34 Further studies on the magnitude of the association of obesity with vascular disease risk factors in youth with T1D are needed.34

As with any comparison between 2 large clinical registries, differences in the data collection methods are a potential limitation. Severe hypoglycemia events were clinic-reported for both registries; however, the type of data extraction—manual for T1DX and automatic for DPV—may have led to underreporting of events within T1DX. For this report, although there may be some differences in the collection of height and weight measurements across the clinics, it is highly unlikely that all errors are in the same direction, thus reducing the possibility of systematic bias. In addition, standardized measurements of height and weight via the use of calibrated devices and trained personnel are standard in pediatric endocrine/diabetes clinics taking care of children with T1D. Regarding possible differences in HbA1c measurements, we have reported previously that in both registries HbA1c methods are DCCT standardized and 3 different sensitivity analyses did not change results in a comparison focused on between-registry HbA1c differences in children <6 years of age.19 It is possible, however, that assay variation may mask between-registry HbA1c differences in children <6 years of age.18 It also should be noted that the reference tables used to calculate BMIZ are somewhat outdated, particularly CDC data, which was collected before 2000. The KiGGS reference tables are also somewhat dated, because the normative data were collected from 2003 to 2006. However, for the aim of comparing BMI between the registries, the potentially outdated reference tables are not a limitation. Finally, the DPV registry is a population-based sample that included 70%-90% of all potential patients in Germany and Austria whereas the T1DX registry is a sample of patients from participating pediatric diabetes centers staffed by pediatric endocrinologists and only includes the children of families who volunteered to participate. The T1DX registry participants represent about one-fourth of the patients with T1D who are followed at a T1D Exchange Clinic Network site16; thus, the T1DX data may not be representative of all youth with T1D in the US. Although it is difficult to compare socio-economic status between the 2 registries, the proportion of minorities was similar for each group—21% of T1DX participants were not non-Hispanic white and 20% of DPV participants had a history of migration (defined as at least one parent born outside of Germany or Austria).

In conclusion, the obesity epidemic has not spared youth with T1D, because youth in both the T1DX and DPV registries have increased BMIZ, with youth in the T1DX being more obese than those in DPV. Increased obesity in youth with T1D has negative implications for glucose control, vascular disease risk factors, and future health outcomes. Data from large registries such as the T1DX and the DPV allow for a comparison of diabetes care and the opportunity to focus clinical care to improve outcomes for people with T1D. An important future direction is to further delve into how practices differ between countries in an effort to discover which diabetes care strategies are most effective for youth with T1D.

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Reprint requests: Stephanie N. DuBose, MPH, Jaeb Center for Health Research, 15310 Amberly Drive, Suite 350, Tampa, FL 33647. E-mail: T1DStats@jaeb.org

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Appendix

Additional members of T1DX include (clinic network sites with participating principal investigators [PI], coinvestigators [I], and coordinators [C] ordered by the number of participants recruited per site as of August 1, 2012):

Children’s Hospital of Philadelphia, Philadelphia, PA (n = 1451): Steven Willi (PI); Terri Lipman (I); Tammy Calvano (C); Olena Kucheruk (C); Pantea Minnock (C); Chau Nguyen (C).

Barbara Davis Center for Childhood Diabetes, Aurora, CO (n = 1440): Georgeanna Klingensmith (PI); Carolyn Banion (I); Jennifer Barker (I); Cindy Cain (I); Peter Chase (I); Sandy Hoops (I); Megan Kelsy (I); Georgeanna Klingensmith (I); David Maahs (I); Cathy Mowry (I); Kristen Nadeau (I); Jennifer Raymond (I); Marian Reters (I); Arleta Reters (I); Robert Slover (I); Andrea Steck (I); Paul Wadwa (I); Philippe Walravens (I); Philip Zeitler (I); Heidi Haro (C); Katherine Manseau (C).

SUNY Upstate Medical University, Syracuse, NY (n = 1301): Ruth Weinstock (PI); Roberto Izquierdo (I); Umar Sheik (I); Patricia Conboy (C); Jane Bulger (C); Suzan Bzdick (C).

Naomi Berrie Diabetes Center, Columbia University P&S, New York City, NY (n = 1249): Robin Goland (PI); Rachelle Gandica (I); Lindsay Weiner (I); Steve Cook (C); Ellen Greenberg (C); Kevin Kohn (C); Sarah Pollack (C).

University of Michigan, Ann Arbor, MI (n = 927): Joyce Lee (PI); Brigid Gregg (I); Meng Tan (I); Kimberly Burgh (C); Ashley Eason (C).

University of Colorado/Denver, Barbara Davis Center for Childhood Diabetes, Aurora, CO (n = 897): Satish Garg (PI); Aaron Michels (I); Lisa Myers (C).

Riley Hospital for Children, Indiana University School of Medicine, Indianapolis, IN (n = 859): Linda DiMeglio (PI); Tamara Hannon (I); Donald Orr (I); Christy Cruz (C); Stephanie Woerner (C).

Children’s Hospital Boston, Boston, MA (n = 836): Joseph Wolfsdorf (PI); Maryanne Quinn (I); Olivia Tawa (C).

Helen DeVos Children’s Hospital Endocrinology and Diabetes, Grand Rapids, MI (n = 576): Ayse Cemeroglu (PI); Yaw Appiagyei-Dankah (I); Maala Daniel (I); Daniel Postellon (I); Michael Racine (I); Michael Wood (I); Lora Kleis (C).

University of Washington, Diabetes Care Center, Seattle, WA (n = 569): Irl Hirsch (PI); Anthony DeSantis (I); DC Dugdale (I); R Alan Fadler (I); Lisa Gilliam (I); Carla Greenbaum (I); Mary Janci (I); Peggy Odegard (I); Dace Trence (I); Brent Wisse (I); Emily Batts (C); Angela Dove (C); Deborah Hefty (C); Dori Khakpour (C); Jani Klein (C); Kristen Kuhns (C); Marli McCulloch-Olson (C); Christina Peterson (C); Mary Ramey (C); Marissa St. Marie (C); Pam Thomson (C); Christine Webber (C).

Rocky Mountain Diabetes & Osteoporosis Center, Idaho Falls, ID (n = 557): David Liljenquist (PI); Mark Sulik (PI); Carl Vance (PI); Tiffany Coughenour (I); Chris Brown (C); Jean Halford (C); Andrea Prudent (C); Shanda Rigby (C); Brandon Robison (C).

BD Diabetes Center at Goryeb Children’s Hospital, Morristown, NJ (n = 542): Harold Starkman (PI); Tymara Berry (I); Barbara Cerame (I); Daisy Chiu (I); Laurie Ebner-Lyon (I); Frances Guevarra (I); Kristen Sabanosh (I); Lawrence Silverman (I); Christine Wagner (I); Marie Fox (C).

Stanford University School of Medicine, Division of Pediatric Endocrinology, Stanford, CA (n = 525): Bruce Buckingham (PI); Avni Shah (I); Kimberly Caswell (C); Breanne Harris (C).

International Diabetes Center/Park Nicollet Adult Endocrinology, Minneapolis, MN (n = 514): Richard Bergenstal (PI); Amy Criego (I); Greg Damberg (I); Glenn Mattin (I); Margaret Powers (I); David Tridgell (I); Cassie Burt (C); Beth Olson (C); LeeAnn Thomas (C).

Joslin Diabetes Center-Pediatric, Boston, MA (n = 451): Sanjeev Mehta (PI); Michelle Katz (I); Lori Laffel (I); Joanne Hathaway (C); Roxanne Phillips (C).

Yale Pediatric Diabetes Program, New Haven, CT (n = 398): Eda Cengiz (PI); William Tamborlane (I); Darryl Cappiello (C); Amy Steffen (C); Melinda Zgorski (C).

University of Southern California-Community Diabetes Initiatives, Los Angeles, CA (n = 365): Anne Peters (PI); Valerie Ruelas (C).

Duke University Medical Center - Pediatric Endocrine Division, Durham, NC (n = 364): Robert Benjamin (PI); Deanna Adkins (I); Juanita Cuaffee (C); Amber Spruill (C).

International Diabetes Center/Park Nicollet Pediatric Endocrinology, Minneapolis, MN (n = 357): Richard Bergenstal (PI); Amy Criego (I); Greg Damberg (I); Glenn Mattin (I); Margaret Powers (I); David Tridgell (I); Cassie Burt (C); Beth Olson (C); LeeAnn Thomas (C).

Northwestern University, Chicago, IL (n = 352): Grazia Allepo-Kacmarek (PI); Teresa Derby (C); Elaine Massaro (C); Kimberly Webb (C).

University of Virginia Health System, Charlottesville, VA (n = 342): Christine Burt Solorzano (PI); Mark DeBoer (I); Helen Madison (C).
Washington University, St. Louis, MO (n = 342): Janet McGill (PI); Lori Buechner (C); Mary Jane Clifton (C); Stacy Hurst (C); Sarah Kessel (C); Carol Recklein (C).

University of Iowa Children’s Hospital, Iowa City, IA (n = 327): Eva Tsalikian (PI); Michael Tansey (I); Joanne Cabbage (C); Julie Coffey (C); Sarah Salamati (C).

Children’s Mercy Hospital, Kansas City, MO (n = 323): Mark Clements (PI); Sripiya Raman (I); Angela Turpin (I); Jennifer Bedard (C); Cyndy Cohoon (C); Aliza Elrod (C); Amanda Fridlington (C); Lois Hester (C).

Henry Ford Health System, Detroit, MI (n = 316): Davida Kruger (PI); Andreae Tassopoulos. University of Florida, Gainesville, FL (n = 306): Desmond Schatz (PI); Michael Clare-Salzler (I); Kenneth Cusi (I); Colleen Digman (I); Becky Fudge (I); Mike Haller (I); Collette Meehan (I); Henry Rohrs (I); Janet Silverstein (I); Sujata Wagh (I); Miriam Cintron (C); Eleni Sheehan (C); Jamie Thomas (C).

Children’s Hospital of Orange County, Orange, CA (n = 305): Mark Daniels (PI); Susan Clark (I); Timothy Flannery (I); Nikta Forghani (I); Ajanta Naidu (I); Christina Reh (I); Peggy Scoggin (I); Lien Trinh (I); Natalie Ayala (C); Rebecca Quintana (C); Heather Speer (C).

Central Ohio Pediatrics Endocrinology and Diabetes Services, Columbus, OH (n = 303): William Zipf (PI); Diane Seiple (C).

Avera Research Institute, Sioux Falls, SD (n = 281) Julia Kittelsrud (PI); Ashutosh Gupta (I); Vikki Peterson (C); Ashley Stoker (C).

University of California, San Diego, CA (n = 280): Michael Gottschalk (PI); Marla Hashiguchi (C); Katheryn Smith (C).

University of South Florida Diabetes Center, Tampa, FL (n = 276): Henry Rodriguez (PI); Craig Bobik (C); Danielle Henson (C).

Vanderbilt Eskidn Diabetes Clinic, Nashville, TN (n = 276): Jill Simmons (PI); Amy Potter (I); Margo Black (C); Faith Brendle (C).

Case Western Reserve University, Cleveland, OH (n = 251): Rose Gubitosis-Klug (PI); Beth Kaminski (I); Susan Bergant (C); Wendy Campbell (C); Catherine Tasi (C).

University of Oklahoma Health Sciences Center, Oklahoma City, OK (n = 243): Kenneth Copeland (PI); Joni Beck (I); Joane Less (C); Jill Schanuel (C); Jennifer Tolbert (C).

University of California, San Francisco Medical Center (UCSF), San Francisco, CA (n = 237): Saleh Adi (PI); Andrea Gerard-Gonzalez (I); Stephen Gitetman (I); Nassin Chettout (C); Christine Torok (C).

Seattle Children’s Hospital, Seattle, WA (n = 226): Catherine Pihoker (PI); Joyce Yi-Frazier (I); Susan Kearns (C).

Children’s Hospital of Pittsburgh of UPMC, Pittsburgh, PA (n = 217): Ingrid Libman (PI); Vicky Bills (C); Ana Diaz (C); Julie Duke (C).

University of Minnesota, Minneapolis, MN (n = 204): Brandon Nathan (PI); Antoinette Moran (I); Melena Bellin (I); Shannon Beasley (C); Anne Kogler (C); Janice Leschlyshyn (C); Kara Schmid (C); Anne Street (C).

Greenville Hospital System Pediatric Endocrinology, Greenville, SC (n = 196): Bryce Nelson (PI); Carrie Frost (C); Erin Reifeis (C).

Baylor College of Medicine/Texas Children’s Hospital, Houston, TX (n = 187): Morey Hammond (PI); Fida Bacha (I); Maria Caldas-Vasquez (I); Sara Klinepeter (I); Maria Reondon (I); Rosa Berlanga (C); Teresa Falk (C); Elizabeth Barnes (C); Janette Gonzalez (C); Cecilia Martinez (C); Mariam Pontifes (C); Ronald Yulatic (C).

The Diabetes Center, PLLC, Ocean Springs, MS (n = 187): Kathleen Arnold (PI); Traci Evans (I); Sharon Sellers (C).

University of Utah-Utah Diabetes Center, Salt Lake City, UT (n = 181): Vandana Raman (PI); Carol Foster (I); Mary Murray (I); Vandana Raman (I); Trina Brown (C); Hillarie Slater (C); Karen Wheeler (C).

University of Massachusetts Medical School, Worcester, MA (n = 179): David Harlan (PI); Mary Lee (I); John-Paul Lock (I); Celia Hartigan (C); Lisa Hubacz (C).

University of North Carolina Diabetes Care Center, Durham, NC (n = 179): John Buse (PI); Ali Calikoglu (I); Joseph Largay (I); Laura Young (I); Helen Brown (C); Vinnie Duncan (C); Michelle Duclos (C); Julie Tricome (C).

Sanford Research/USD, Sioux Falls, SD (n = 178): Verdayne Brandenburg (PI); Julie Blehm (I); Julie Hallanger-Johnson (I); Dawn Hanson (C); Corliss Miller (C); Jennifer Weiss (C).

The Research Institute at Nationwide Children’s Hospital, Columbus, OH (n = 168): Robert Hoffman (PI); Monika Chaudhari (I); David Repaske (I); Elizabeth Gilson (C); Jesse Haines (C).

St. Vincent Healthcare/Internal Medicine and Diabetes, Billings, MT (n = 165): Justen Rudolph (PI); Charles McClave (I); Doris Biersdorf (C).

Medcenter One, Bismarck, ND (n = 156): Anthony Tello (PI); Julie Blehm (I); Donna Amundson (C); Rhonda Ward (C).

University of Pennsylvania School of Medicine/Rodebaugh Diabetes Center, Philadelphia, PA (n = 156): Michael Rickels (PI); Cornelia Dalton-Bakes (C); Eileen Markman (C); Amy Peleckis (C); Nora Rosenfeld (C).

Cincinnati Children’s Hospital Medical Center, Cincinnati, OH (n = 148): Lawrence Dolan (PI); Sarah Corathers (I); Jessica Kichler (I); Holly Baugh (C); Debbie Standiford (C).

Rockwood Research Center, PS, Spokane, WA (n = 132): Jeanne Hassing (PI); Jennifer Jones (I); Stephen Willis (I); Stephen Willis (I); Carol Wysam (I); Lisa Davis (C).

Johns Hopkins University Pediatric Endocrinology, Baltimore, MD (n = 120): Scott Blackman (PI); Kimber-Lee Abel (C); Loretta Clark (C); Andrea Jonas (C); Ellie Kagan (C).

University of Miami, Diabetes Research Institute, Miami, FL (n = 119): Jay Sosenko (PI); Carlos Blashke (C); Della Cabbage (C); Julie Coffey (C); Sarah Salamati (C); Maria Caldas-Vasquez (C); Cecilia Martinez (C); Mariam Pontifes (C); Ronald Yulatic (C).

Regional Health Clinical Research, Rapid City, SD (n = 118): Rachel Edele (PI); Thomas Repas (I); Denise Baldwin (C); Trista Borgwardt (C); Christina Conroy (C);
Kelly DeGrote (C); Rod Marchiano (C); Michelle Wasson (C).

Nemours Children’s Clinic, Jacksonville, FL (n = 116): Larry Fox (PI); Nelly Mauras (I); Ligeia Damaso (C); Kim Engler (C).

Cleveland Clinic Department of Endocrinology, Diabetes and Metabolism, Cleveland, OH (n = 111): Marwan Hamaty (PI); Laurence Kennedy (I); Michelle Schweiger (I); Pantelis Konstantinopoulos (C); Carolyn Mawhorter (C); Amy Orsko (C); Denise Rose (C).

Tallahassee Memorial Diabetes Center, Tallahassee, FL (n = 108): Larry Deeb (PI); Kim Rohrbacher (C).

Blanchard Valley Medical Associates, Findlay, OH (n = 100): Leroy Schroeder (PI); Amanda Roark (C).

The Medical College of Wisconsin/Children’s Hospital of WI, Milwaukee, WI (n = 99): Omar Ali (PI); Joanna Kramer (C); Donna Whiston-Jones (C).

Vanderbilt Eskind Diabetes Clinic, Nashville, TN (n = 98): Amy Potter (PI); Margo Black (C); Faith Brendle (C).

Kaiser Permanente, Vallejo, CA (n = 74): Heidi Gassner (PI); Sobha Kollipara (I); Vicky Bills (C); Julie Duke (C).

St. Joseph’s Children’s Hospital, Paterson, NJ (n = 53): Katerina Harwood (PI); Vijaya Prasad (I); Judy Braul (C).

DPV sites contributing data include: