Body Mass Index Changes in Youth in the First Year after Type 1 Diabetes Diagnosis

Brigid Gregg, MD[1], Crystal G. Connor, MS, MPH[2], Katrina J. Ruedy, MSPH[2], Roy W. Beck, MD, PhD[2], Craig Kollman, PhD[2], Desmond Schatz, MD[3], Eda Cengiz, MD[4], Breanne Harris[5], William V. Tamborlane, MD[4], Georgeanna J. Klingensmith, MD[6], and Joyce M. Lee, MD, MPH[1,7], on behalf of the Pediatric Diabetes Consortium*

Objectives To describe changes in weight and body mass index (BMI) during the first year following diagnosis of type 1 diabetes (T1D) and associations with demographic and clinical characteristics.

Study design The Pediatric Diabetes Consortium includes 7 US centers with prospective longitudinal data from initial T1D diagnosis. This analysis includes 530 youth with diabetes duration of ≥1 year and measures of BMI at 3 and 12 months after diagnosis. BMI trajectory of participants and relationships between the change in BMI z-score from baseline (3 months) to 12 months with demographic characteristics, hemoglobin A1c at baseline, and insulin delivery mode at baseline were evaluated.

Results As a group, BMI z-scores increased sharply from diagnosis for 1-3 months but remained relatively stable from +0.51 at 3 months to +0.48 at 12 months. Children aged 2-<5 years experienced a significant positive change in BMI z-score between 3 and 12 months, and there was a similar trend among girls that did not reach statistical significance. No significant differences were found for race, socioeconomic status, or insulin delivery mode.

Conclusions These data suggest that increased BMI during the first year of treatment of most youth with T1D reflects regain of weight lost before diagnosis. There is, however, a propensity toward additional weight gain in younger children and girls. *(J Pediatr 2015;166:1265-9)*.

The prevalence of childhood overweight and obesity has risen in the US during the last 30 years.[1] Obesity is prevalent among children with type 2 diabetes, but recent studies reveal that children with type 1 diabetes (T1D) are also overweight and obese.[2,3] In children with T1D, obesity has been linked with an increased risk for metabolic syndrome.[4,5] Furthermore, adults who gained excessive weight during the Diabetes Control and Complications Trial had greater rates of metabolic syndrome and atherosclerosis during the Epidemiology of Diabetes Interventions and Complications follow-up study.[6,7] Given the adverse consequences of excess weight for individuals with T1D, a better understanding of the evolution of weight patterns during the first year after the diagnosis of T1D may be important for identifying subgroups of children who may be at particular risk for excess weight gain and for the design and timing of lifestyle intervention strategies that could mitigate excess weight gain. Although in previous studies authors have examined weight gain in children with newly diagnosed T1D,[8-10] they were either small, single-center studies, retrospective case analyses, or the authors examined patients on older insulin analogues.

The overall objective of the Pediatric Diabetes Consortium (PDC) T1D New Onset Study is to assess contemporary clinical outcomes in a large and geographically diverse multicenter prospective cohort of children starting at diagnosis of T1D. These data provided the opportunity to examine whether excessive weight gain in youth with new-onset T1D was limited to the early, postdiagnosis period, which is likely reflective of regain of weight that was lost before diagnosis or extended throughout the first year of treatment, which would imply an effect of treatment itself. The other aims of our analyses reported were to assess whether changes in weight, body mass index (BMI), BMI percentile, and overweight status (BMI ≥85th percentile) during the first year differed by age and sex and differences in metabolic control (hemoglobin A1c [HbA1c]) and the type of insulin regimen.

BMI	Body mass index
HbA1c	Hemoglobin A1c
PDC	Pediatric Diabetes Consortium
T1D	Type 1 diabetes

From the [1]Department of Pediatric Endocrinology, Mott Children's Hospital, University of Michigan, Ann Arbor, MI; [2]Jaeb Center for Health Research, Tampa, FL; [3]Pediatric Endocrinology, University of Florida, Gainesville, FL; [4]Pediatric Endocrinology, Yale University, New Haven, CT; [5]Pediatric Endocrinology, Stanford University, Stanford, CA; [6]Department of Pediatrics, Barbara Davis Center for Childhood Diabetes, University of Colorado, Aurora, CO; and [7]Child Health Evaluation and Research Unit, University of Michigan, Ann Arbor, MI

*List of members of the Pediatric Diabetes Consortium is available at www.jpeds.com (**Appendix**).

The Pediatric Diabetes Consortium and its activities are supported by the Jaeb Center for Health Research Foundation through an unrestrictive grant from Novo Nordisk. The University of Michigan center was supported by the Michigan Diabetes Research and Training Center funded by the National Institute of Diabetes and Digestive and Kidney Diseases (DK020572). G.K. receives payment for educational consultation as the planner and participant in a continuing medical education course for the Eli Lilly Company, and serves as a consultant for Novo Nordisk. W.T. serves as a consultant for Novo Nordisk, Bristol-Meyers Squibb, Boehringer Ingelheim, Takeda, and Janssen. The other authors declare no conflicts of interest.

http://dx.doi.org/10.1016/j.jpeds.2015.02.036

Methods

The PDC T1D New Onset Study enrolled 1048 patients with new-onset T1D between July 2009 and April 2011. The protocol was approved by the institutional review board at each of the 7 participating pediatric centers in the US. Informed consent was obtained from participants 18 years of age or older and from parents/guardians of those younger than 18 years of age. Assent also was obtained from participants <18 years of age as required by local institutional review board regulations. Individuals had to be <19 years of age and managed at 1 of the 7 PDC centers within 3 months of diagnosis to be eligible for enrollment in the study. A detailed description of PDC and the design of the study have been published previously.[11] The analyses reported herein include data from 530 participants who met the following criteria: at least 1 diabetes autoantibody present (islet cell autoantibody ICA512/insulinomas-associated protein 2, and/or glutamic acid decarboxylase autoantibody within 91 days of diagnosis, and/or insulin autoantibody within 14 days of diagnosis), age ≥2 years at diagnosis, and BMI available at both 3 and 12 months. Children <2 years of age were excluded from this study because BMI percentiles are not available until after age 2 years.

Of the 1048 enrolled 217 were excluded for not having positive antibodies, 36 were <2 years of age at diagnosis, 189 did not have a BMI measured at 3 months, and 76 did not have a BMI at 12 months. Excluded cases were comparable for sex (46% vs 52% female), race/ethnicity (66% vs 62% white), and BMI percentile at diagnosis (median 49% vs 50%). Among those older than 2 years of age excluded for missing BMI data at either 3 or 12 months (N = 189 + 76 = 265), age at diagnosis was comparable with those included in the analysis (mean 9.6 vs 9.5 years). Information about weight before diagnosis, detailed information about weight measurements, and diet and exercise were not available because the data for this study were derived from patient medical records where such data are not captured routinely.

Demographic, socioeconomic, and clinical characteristics data were collected from medical records and from interviews with the participant and/or parent. Follow-up visits were completed per routine clinical care visits, and all data from visits during the first year postdiagnosis were entered in the study database using standardized electronic case report forms.

BMI was calculated from the height and weight measurements closest to diagnosis (±14 days), 1 month (15-45 days from diagnosis), 3 months (46-136 days from diagnosis), 6 months (137-227 days from diagnosis), 9 months (228-318 days from diagnosis), and 12 months (319-455 from diagnosis). BMI percentiles and z-scores were determined at each time point and adjusted for age and sex by the use of Centers for Disease Control and Prevention population data and were only available for those 2-20 years of age.[12] Baseline was considered to be 3 months postdiagnosis for this analysis because children with new-onset T1D have been shown to take up to 6-8 weeks to recover their normal body composition after diagnosis.[8] Diabetes ketoacidosis was defined according to Diabetes Control and Complications Trial criteria of pH <7.3 or HCO_3 <15 mEq/L and treatment in a health care facility.[13]

Statistical Analyses

A least squares regression model was used to assess the association of clinical site, age at baseline, sex, race/ethnicity, parent education, family income, family structure, diabetes ketoacidosis at diagnosis, number of positive autoantibodies, HbA1c at baseline, and insulin regimen (pump or injections) at baseline with the change in BMI z-score from baseline to 12 months postdiagnosis of T1D. Tanner stage was unavailable for a large number of the participants and was therefore not included in the analysis. Because of multiple comparisons, only factors with P values <.01 were considered statistically significant, although factors with P values <.10 were included in the model to adjust for potential confounding. Continuous variables were examined for nonlinear trends by testing quadratic terms in regression models and none were found in this analysis. All P values are 2-sided, and analyses were conducted via SAS version 9.3 (SAS Institute, Cary, North Carolina).

Results

At 3 months after diagnosis, the mean age ± SD for the 530 participants was 9.7 ± 3.7 years, and 52% were female. The majority was white non-Hispanic, had private health insurance, and lived in 2-parent households. Mean ± SD HbA1c % was 7.1 ± 1.1 (range 5.1-11.5; **Table I**).

The median (IQR) BMI percentile at diagnosis was 50% (20%-79%), increasing to 67% (46%-87%) at 1 month and then remained relatively constant throughout the first year of T1D (**Figure 1**). The large majority (94%) of the 372 children who were considered to have a normal weight (<85th percentile) at 3 months remained at normal weight at 12 months. Of the 158 children who had a BMI >85th percentile at 3 months, 20% decreased to <85th percentile and 80% remained >85th percentile at 12 months (**Table II**). The mean (±SD) HbA1c was 7.8 ± 1.5% at 12 months.

Younger children in the 2- to 5-year age group experienced a significant positive change in BMI z-score between 3 and 12 months and there was a similar trend among female patients that did not reach statistical significance. No significant differences were found for race, socioeconomic status, total daily insulin dose (per kilogram), or insulin delivery mode (**Table I**).

Discussion

In this prospective longitudinal study, the largest increases in BMI during the first year of T1D occurred during the first 3 months postdiagnosis, which is likely reflective of weight