Contextual Factors Are Associated with Diet Quality in Youth with Type 1 Diabetes Mellitus

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ABSTRACT

This study examined differences in diet quality by meal type, location, and time of week in youth with type 1 diabetes mellitus. A sample of youth with type 1 diabetes mellitus (n=252; 48% female) age 8 to 18 years (mean±standard deviation=13.2±2.8 years) with diabetes duration ≥1 year (mean±standard deviation=6.3±3.4 years) completed 3-day diet records. Multilevel linear regression models tested for differences in diet quality indicators by meal type, location, and time of week (weekdays vs weekends). Participants showed greater energy intake and poorer diet quality on weekends relative to weekdays, with lower intake of fruit and vegetables, and higher intake of total and saturated fat. Differences in diet quality were seen across meal types, with higher nutrient density at breakfast and dinner than at lunch and snacks. Participants reported the highest whole-grain and lowest fat intake at breakfast, but higher added sugar than at lunch or dinner. Dinner was characterized by the highest fruit intake, lowest added sugar, and lowest glycemic load, but also the highest sodium intake. The poorest nutrient density and highest added sugar occurred during snacks. Diet quality was poorer for meals consumed away from home than those consumed at home for breakfast, dinner, and snacks. Findings regarding lunch meal location were mixed, with higher nutrient density, lower glycemic load, and less added sugar at home lunches, and lower total fat, saturated fat, and sodium at lunches away from home. Findings indicate impacts of meal type, location, and time of week on diet quality, suggesting targets for nutrition education and behavioral interventions.
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DIETS OF YOUTH WITH TYPE 1 DIABETES MELLITUS are of suboptimal nutritional quality, exhibiting inadequate intake of fruits, vegetables, and whole grains, and excessive intake of total and saturated fat.[1,2] Such dietary patterns can increase risk of cardiometabolic complications in this population.[3] Evidence suggests that multiple aspects of dietary intake can influence glycemic control[4-8] and cardiovascular risk,[5,9,10] suggesting the importance of efforts to improve diet quality.

Research in the general population indicates the influence of environmental contexts surrounding eating occasions on dietary intake.[11,12] Meal type is one such contextual factor. Snack foods among children are more likely than main meals to consist primarily of desserts, salty snacks, and sweetened beverages[13]; accordingly, snacking is associated with greater intake of added sugar and oil.[14] Breakfast consumption is related to higher diet quality in children and adults.[15,16] However, distinguishing nutritional characteristics of other meals have not been studied. Meal location is another contextual factor with demonstrated influence on dietary intake. Eating away from home is associated with greater energy intake and lower diet quality in both children and adults.[17,18] Intake at school can be influenced by participation in the National School Lunch Program, which is associated with greater nutrient adequacy but also excessive sodium intake.[19] In addition, dietary intake varies considerably with respect to time of week, with lower diet quality in both children and adults on weekends vs weekdays, evidenced by increased fat,[20-22] energy-dense snack foods[21] and added sugar,[22] as well as decreased fiber.[22]

Differences in dietary patterns according to these meal-related characteristics have not been examined in youth with type 1 diabetes mellitus, who experience dietary demands related to disease management. Research in the general population supports the potential efficacy of theory-based behavioral interventions to change dietary habits.[23] However, previous research has not tested behavioral approaches to improve dietary intake in this population.[1] Therefore, information on the association of meal contextual factors with dietary intake would be instructive in the development of effective intervention strategies. The purpose of this study was to examine differences in diet quality according to meal type, location, and time of week in a sample of youth with type 1 diabetes mellitus. Several indicators of diet quality are considered, including intakes of food groups, energy, and macronutrients, as well as measures of overall diet quality.

METHODS

Design, Sample, and Procedures

Data from a cross-sectional study of diabetes and dietary behaviors, conducted from July 2008 through February 2009 at a pediatric diabetes center in Boston, MA, were used for this secondary analysis. Eligibility criteria included age 8 to 18 years, diagnosis of type 1 diabetes mellitus ≥1 year, daily insulin dose ≥0.5 units/kg, absence of chronic illness (particularly any gastrointestinal disease, such as celiac disease) or medication that interferes with diabetes management or glucose metabolism, and ability to communicate in English. Parents and 18-year-old youth provided informed consent; children younger than 18 years provided assent. Of 455 eligible youth invited to participate, 302 (66.4%) enrolled in the study. In families with multiple siblings enrolled, data from the sibling with the longest diabetes duration were retained, resulting in elimination of 11 subjects. Of the remaining 291 subjects, 252 completed diet records, providing data on 3,756 meals. There were no differences in diabetes duration, age, sex, race, income, or parent education between those completing and not completing diet records; however, those completing diet records were more likely to be using an insulin pump (68.7% vs 41.9%; χ^2 P=0.003). Study procedures were approved by the Joslin Diabetes Center Committee on Human Studies along with a Eunice Kennedy Shriver National Institute of Child Health and Human Development reliance agreement.

Biomedical data including child height, weight, date of diagnosis, hemoglobin A1c (HbA1c; reference range 4% to 6%; Tosoh 2.2 device, Tosoh Corporation), insulin regimen, and blood glucose monitoring frequency (from meter download or patient report) were extracted from medical records. Youth reported frequency of moderate and vigorous physical activity.[24] Parents reported demographic characteristics. Families completed 3-day food records on the child's dietary intake (2 weekdays and 1 weekend day). Participants were given instructions on how to measure and report food and beverage consumption. Families were asked to use measuring utensils if available or provide their best estimate of portion size, and to note specific details for each food, including names of brands or restaurants, and any other labeling information (eg, low fat/low sugar). Nutrition Data System for Research software (Nutrition Coordinating Center, University of Minnesota) was used to analyze food records.

Contextual factors examined as predictors of dietary outcomes included meal type (breakfast, lunch, dinner, or snack), meal location, and time of week (weekday or weekend). Dietary indicators included energy intake, macronutrient distribution (percent energy intake from carbohydrate, protein, total fat, and saturated fat), sodium intake, added sugar intake (as percent of energy intake), servings of fruit and vegetables, servings of whole grains, glycemic index (GI), and glycemic load (GL). In addition, the Nutrient-Rich Foods Index 9.3 (NRF9.3) and whole plant food density were examined as indices of overall diet quality. The NRF9.3 is calculated as the sum of the percent consumed of referent daily value of nine nutrients to encourage (ie, protein, fiber, vitamin A, vitamin C, vitamin E, calcium, iron, magnesium, and potassium) subtracted by the sum of the percent consumed of referent daily value of three nutrients to limit (saturated fat, added sugar, and sodium), expressed per 100 kcal.[25] Whole plant food density is calculated as the number of servings of whole grains, whole fruit, vegetables, legumes, nuts, and seeds per 1,000 kcal consumed.[26]

Analyses

Separate multilevel linear regression models tested for differences in dietary quality indicators by meal type, location, and time of week. This modeling strategy accounts for the correlation between repeated measures (meals) within subjects by including a random intercept. Day of week was dichotomized as weekday vs weekend; meal location was dichotomized as home vs away from home. Due to the nonindependence of meal type and location (eg, most meals consumed at school were lunches, few restaurant meals were breakfasts), comparisons by meal location were conducted separately for each meal type. Statistical significance was adjusted for multiple comparisons using the Sidak method. Meal energy intake was included as a covariate in all models evaluating meal type differences, and in those models examining day of week and location differences if the outcome was significantly related to energy intake in bivariate analyses (P<0.05). Models evaluating associations of meal type and time of week with dietary intake required no additional covariates because subjects reported intake for each meal time as well as weekend and weekday times. For models evaluating associations with meal location, potential confounding by age, sex, household income, body mass index percentile, HbA1c, insulin regimen, and physical activity was examined. Variables associated with the dietary outcome of interest were included as covariates. STATA software (version 12, 2011, StataCorp) was used for statistical analyses. Statistical significance was defined as P<0.05.

RESULTS AND DISCUSSION

The sample was approximately half female (52%) and predominantly non-Hispanic white (92%) (Table 1). A majority of the parents had at least a college degree (74%). Youth were predominantly receiving pump therapy (69%), with mean HbA1c of 8.5%±1.3% and mean body mass index percentile of 70.2%±22.5. On average, 34% of youth's energy intake was provided by dinner, 26% by lunch, 22% by snacks, and 19% by breakfast.

Meal diet quality was higher on weekdays vs weekends for most indicators (Table 2), with modestly higher intake of fruit and vegetables (P=0.006), lower energy intake (P=0.001), and lower proportional intake of total fat (P=0.01) and saturated fat (P=0.003). These findings are consistent with previous research in the general population demonstrating differences in dietary intake between weekdays and weekends.[20-22] The majority of the sample used insulin pump therapy, which allows considerable flexibility in dietary intake; weekend/weekday differences might reflect less structured eating occasions during weekends and greater likelihood of recreational intake.

Differences in diet quality indicators were observed according to meal type (Table 2). NRF9.3 was highest at breakfast and dinner meals (P<0.001), while whole plant food density was highest at breakfast and lunch (P<0.001). Breakfast contained the highest carbohydrate and whole-grain intake and the lowest total and saturated fat, although it also contained higher added sugar relative to lunch and