# Mealtime Interactions Relate to Dietary Adherence and Glycemic Control in Young Children With Type 1 Diabetes

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**OBJECTIVE** — This study examined the relationships between parent-child mealtime interactions and dietary adherence and glycemic control in young children with type 1 diabetes. It was hypothesized that young children who exhibited disruptive mealtime behaviors would have more dietary deviations (poorer dietary adherence) and poor glycemic control. It was also hypothesized that parents of young children who used ineffective/coercive parenting strategies at mealtimes would have children with more dietary deviations and poor glycemic control.

**RESEARCH DESIGN AND METHODS** — A total of 35 families of children (aged 2.2–7.9 years) with type 1 diabetes were recruited from a pediatric hospital. Families had at least three meals videotaped in their home, which were coded for parent, child, and eating behaviors, using the Dyadic Interaction Nomenclature for Eating. Children's dietary adherence was assessed according to deviations from the prescribed number of carbohydrate units per meal. Children's average glycemic excursion was assessed prospectively for 2 weeks, using a standardized home blood glucose meter.

**RESULTS** — Findings demonstrated significant positive relationships between children's mealtime behavior, dietary deviations, and glycemic control. An examination of parent behaviors revealed significant positive correlations between parents' use of ineffective/coercive parenting strategies and children's dietary deviations and glycemic control.

**CONCLUSIONS** — This was the first study to examine the relationship between parent-child mealtime interactions and health outcomes in young children with type 1 diabetes. The mealtime problems examined can be improved through specific behavioral interventions. Future research is needed to examine how parent-child interactions at mealtimes relate to children's health outcomes to inform clinical care.

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Type 1 diabetes is a common chronic illness and may be increasing in incidence among children <7 years old (1,2). Diabetes management in young children presents many challenges that can impact health outcomes (3–5). Physiologically, children in this age range are frequently more insulin sensitive than older children with type 1 diabetes, which may complicate families' ability to regulate children's blood glucose levels through a combination of insulin usage and carbohydrate intake (5,6). Developmentally, young children with type 1 diabetes may be at an increased risk for poor treatment adherence because of aspects of normal child development, including increased independence seeking, transient food preferences, emotional lability, and behavioral resistance (7).

Within the behavioral science literature, research has demonstrated that parents of young children with type 1 diabetes commonly report mealtimes and adherence to the diabetes dietary recommendations to be among the most difficult components of their child's care (3). Based on this, our previous research has systematically sought to examine the mealtimes of young children with type 1 diabetes to determine whether mealtimes are different for these families compared with families of control children. Specifically, in a study of 40 parents of young children with type 1 diabetes and 40 parents of control children, we found that parents of young children with type 1 diabetes perceived more child mealtime behavior problems and reported more parenting stress than parents of control subjects (8). However, in a follow-up study of 26 families of young children with type 1 diabetes and 26 control families, using direct observation of mealtimes, we found no differences in the frequency of mealtime behaviors (9). Thus, the outcomes of these studies suggest that although parents of young children with type 1 diabetes may commonly perceive child mealtime behavior problems, the actual frequency of disruptive mealtime behaviors is similar to children without type 1 diabetes, suggesting a bias in parents' perceptions of mealtimes. These previous studies have not examined the potential impact of children's behavior at mealtimes on health outcomes, such as children's dietary adherence and blood glucose control.

The purpose of this study was to examine the relationships between parent-child mealtime interactions and children's dietary adherence and blood glucose control in a sample of young children with type 1 diabetes. Based on the literature, the following specific hypotheses were tested. *1*) Young children who exhibit disruptive mealtime behaviors will have more di-

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**Abbreviations:** BPFAS, Behavioral Pediatrics Feeding Assessment Scale; DINE, Dyadic Interaction Nomenclature for Eating.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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etary deviations (poorer dietary adherence). 2) Young children who exhibit disruptive mealtime behaviors will have poor metabolic control, as measured by average daily blood glucose levels over a 2-week period. 3) Parents of young children who have more dietary deviations (poorer dietary adherence) will engage in ineffective/coercive behaviors at mealtimes and will report problems at mealtimes. 4) Parents of young children who engage in ineffective/coercive behaviors at mealtimes will have children with poor metabolic control.

## RESEARCH DESIGN AND METHODS

This study recruited 35 young children and their parents from the pediatric diabetes center at Cincinnati Children's Hospital Medical Center. The eligibility criteria for this study included: child's age between 2 and 8 years old, a confirmed diagnosis of type 1 diabetes for at least 1 year, child had no other diseases/conditions know to affect growth, and the family was English speaking. A patient database maintained by the pediatric diabetes center was used to generate a preliminary list of 109 eligible families. From that list, families were contacted to participate in a research project examining eating behaviors and parents' concerns about hypoglycemia, which involved questionnaires and videotaping in the home. A total of 83 parents who were contacted agreed to complete the questionnaires (76% response rate). In addition, the first 35 families who consented to completing the questionnaires and videotaping were enrolled in the current study. Families who elected not to participate reported concern with having mealtimes videotaped and/or the extra time needed to complete the diet records as their primary reasons for declining participation. For this study, children were not excluded based on the type of insulin management prescribed. In total, 27 children followed a conventional insulin therapy regimen, which consisted of 2–3 injections each day of short- and intermediate-acting insulin and a regular schedule of feedings planned throughout the day to coincide with insulin peaks. Eight children were managed according to an intensive insulin therapy regimen. Children following an intensive regimen took either multiple daily injections of short-acting insulin before each feeding and one injection of a long-acting insulin (i.e., Lantus) each day to manage glucose levels between feedings ($n = 1$) or used a continuous subcutaneous insulin infusion pump to administer insulin throughout the day ($n = 7$). The ratio of young children who followed a conventional insulin regimen to children who followed an intensive regimen in this study closely approximated the patient population of the pediatric diabetes center at the time of the study (75% conventionally managed).

The study's purpose and procedures were approved by the Cincinnati Children's Hospital institutional review board before subject recruitment. This study followed a standardized protocol for obtaining data on children's dietary intake and mealtime behaviors from three representative family meals, which has been discussed previously (9). For this study, the mean number of home visits needed to obtain at least three representative meals was 3.11 ± 0.33. Families' diet records of the videotaped meals were reviewed by a registered dietitian and analyzed, using the Minnesota Nutrition Data System (1996 version; Nutrition Coordinating Center, University of Minnesota).

To measure children's average glycemic control, families were given one FreeStyle (TheraSense, Alameda, CA) home blood glucose meter to test their child's blood glucose during the study. Families were instructed to use this meter to test their child's blood glucose at least four times daily for 2 weeks, during which time they also participated in the mealtime videotaping. Children tested their blood glucose a mean of 4.8 ± 1.8 times per day during the recording period. Children's mean daily blood glucose level was used as a dependent measure in this study.

All children had their weight and height measured at the pediatric diabetes center according to a standardized protocol within the 2 weeks of study participation (9,10). Children's anthropometric data were evaluated using the Centers for Disease Control and Prevention anthropometric software program (2000 version). Families were reimbursed $70 for participating in this project.

### Dependent measures

**Dietary adherence.** For children following a conventional insulin regimen ($n = 27$), dietary adherence was assessed by counting the number of carbohydrate units added or deleted from each videotaped meal that deviated from the child's individual diet plan, as obtained from the pediatric diabetes center dietitian (11). Thus, if a child were prescribed to eat 5 carbohydrate units at the dinner meal but only ate 3 units during the meal, a carbohydrate deletion of 2 units was recorded. Likewise, if a child were prescribed 3 carbohydrate units at the lunch meal but ate 4 units during the videotaped meal, a carbohydrate addition of 1 unit was recorded. In situations where families practiced carbohydrate loading (e.g., increasing the number of carbohydrate units consumed) to offset vigorous exercise or to treat an episode of hypoglycemia, no deviations were counted. However, a deviation was counted according to a formula that suggested 1 carbohydrate unit per 30 min of vigorous exercise (e.g., sports practice/games) if families did not engage in carbohydrate loading before vigorous exercise. To obtain children's dietary deviation scores, meal records were reviewed by a trained research assistant. Interrater reliability was assessed through a random subset of diet diaries (33%), which were scored independently by a second trained assistant. The κ-coefficients were 0.88 for carbohydrate additions and 0.81 for carbohydrate deletions, which exceed the minimum considered acceptable for interrater reliability (12). The eight children who followed an intensive insulin regimen were excluded from these analyses because they did not have specific carbohydrate goals per meal.

**Observed mealtime behaviors.** Videotaped meals were coded using a valid behavioral coding system, Dyadic Interaction Nomenclature for Eating (DINE) (13). The DINE codes for three categories of behaviors: parent behaviors, child behaviors, and child eating behaviors. Parent behaviors include: direct commands to eat, interrupted commands, coaxes, parent talks, reinforcement, physical prompts, and feeds. Child behaviors include: noncompliance to direct commands, food refusals/complaints, requests for food, child talks, and child away from table/food. Child eating behaviors include: bites, sips, and spit-outs. The DINE codes the majority of behaviors on an occurrence/nonoccurrence basis within 10-s intervals. However, seven behaviors are coded based on the frequency of occurrence of these behaviors within 10 s intervals. These behaviors are direct and interrupted commands, child compliance/noncompliance to direct commands, feeds, bites, and sips. The operational definition for each of the behaviors is available on request.

Meals were viewed a minimum of three times by trained observers. A pri-

**Table 1—*Demographic, anthropometric, and physiological information***

| Variable | |
|---|---|
| Age (years) | 5.6 ± 1.6 |
| Duration of type 1 diabetes diagnosis (months) | 43.5 ± 22.9 |
| Weight (kg) | 22.3 ± 5.0 |
| Height (cm) | 113.2 ± 11.6 |
| Blood glucose level (mg/dl) | 213 ± 48 |
| % blood glucose levels in range (70–200 mg/dl) | 0.54 ± 0.15 |
| $HbA_{1c}$ (%) | 8.3 ± 1.0 |
| Sex | |
| Male | 14 (40) |
| Female | 21 (60) |
| Race | |
| White | 29 (83) |
| Non-white | 6 (17) |
| Socioeconomic status* | |
| I | 6 (17) |
| II | 0 (0) |
| III | 8 (23) |
| IV | 16 (46) |
| V | 5 (14) |
| Marital status: married | 28 (80) |

Data are means ± SD or frequency (%). *The Hollingshead Four-Factor Scale is measured from I (lowest level) to V (highest level).

mary observer coded all of the videotaped meals. Interrater reliability was assessed, using a random subset of the videotapes (33%), which were scored independently by a second observer. The average κ-coefficients were 0.65 for parent behaviors, 0.76 for child behaviors, and 0.90 for child eating behaviors, which exceeded the minimum considered acceptable for interrater reliability (12).

**Parents' perceptions of mealtime behaviors.** Parents' perceptions of mealtimes were recorded using the Behavioral Pediatrics Feeding Assessment Scale (BPFAS), a valid 35-item parent report questionnaire that assesses parent and child behaviors associated with poor nutritional intake (14). For each item, parents are asked to report how often the particular behavior occurs, using a five-point scale, and to indicate whether the behavior is problematic (yes/no). The BPFAS yields four scores: child behavior—frequency, child behavior—problems, parent behavior—frequency, and parent behavior—problems. Frequency scores reflect how often the parent and child behaviors occur. Problem scores reflect the number of behaviors the parents consider to be problematic. Higher scores are suggestive of poorer mealtime functioning. For this study, BPFAS data were obtained from at least one parent who was responsible for managing mealtimes and who participated in the videotaping.

### Data analysis

All data were analyzed using SPSS statistical software (2005 version). Sample characteristics were examined according to means, SDs, and frequencies. Before analyses, possible covariates were checked, including parents' marital status, children's height and weight, and time since diagnosis. Findings revealed significant correlations between children's height and weight and time since diagnosis for three specific behaviors: children's noncompliance to parental commands, parents' use of interrupted commands, and parents' use of physical prompts. Therefore, for these parent-child variables, partial correlations were used to control for these covariates. For the remaining correlations, Pearson correlations were used. In all cases, the α-levels were set at 0.01 to control for multiple tests. To test hypothesis 1, the within-subject frequency of children's mealtime behaviors and dietary adherence were averaged and correlated. Specific child behaviors considered disruptive were selected based on the existing literature, and they included: noncompliance to parental commands to eat, food refusal/complaints, child away from table/food, and child spit-outs (13). To test hypothesis 2, the within-subject frequency of children's disruptive mealtime behaviors were averaged and correlated with children's average daily blood glucose over the 2-week study period. To examine hypothesis 3, the within-subject frequency of parents' mealtime behaviors were averaged and correlated with children's average dietary deviation. Parent behaviors considered coercive/ineffective were determined based on the literature and included: interrupted commands to eat, coaxes, physical prompts, and feeds (13). Correlations were also used to examine the association between parents' perceptions of mealtime problems (BPFAS data) and children's dietary deviations. Finally, to examine hypothesis 4, the within-subject frequency of parents' mealtime behaviors were averaged and correlated with children's average daily blood glucose.

## RESULTS

### Participants

Table 1 presents descriptive statistics for the 35 children who participated in this study.

### Mealtime characteristics

Table 2 summarizes the mealtime characteristics of families who participated in this study. Families of young children added a mean of 0.20 ± 0.30 carbohydrates units and/or deleted a mean of 0.37 ± 0.74 carbohydrate units from their videotaped meals; this corresponded to an average addition of 1 carbohydrate unit every four meals and a deletion of 1 carbohydrate unit every three meals. Overall, the observed mealtime behaviors of families in the present sample were consistent with published data of similarly aged children with type 1 diabetes (9).

### Children's mealtime behaviors and health outcomes

Consistent with hypothesis 1, correlations revealed a positive association between several disruptive child behaviors and the number of carbohydrate units deleted from children's videotaped meals. Specifically, children who were conventionally managed and who ate fewer than the recommended number of carbohydrate units at meals (e.g., had more carbohydrate units deleted) tended to be away from the table ($r = 0.87$, $P < 0.01$), were noncompliant with parental commands to eat ($r = 0.62$, $P < 0.01$), and spit out food ($r = 0.69$, $P < 0.01$). Con-

**Table 2—*Frequency of observed mealtime behaviors***

| DINE behaviors | Mean ± SD | Range |
|---|---|---|
| Parent behaviors | | |
| Direct commands | 2.92 ± 3.19 | 0.00–14.67 |
| Interrupted commands | 3.09 ± 4.50 | 0.00–20.67 |
| Coax | 3.95 ± 4.81 | 0.00–27.00 |
| Feed | 3.23 ± 12.14 | 0.00–59.00 |
| Physical prompt | 1.43 ± 1.72 | 0.00–6.00 |
| Reinforcement | 0.36 ± 0.51 | 0.00–1.67 |
| Parent talk | 34.35 ± 25.32 | 1.00–102.33 |
| Child behaviors | | |
| Away from table | 14.05 ± 18.61 | 0.00–104.00 |
| Child talk | 40.92 ± 31.44 | 2.00–170.67 |
| Food refusal | 1.69 ± 1.90 | 0.00–8.33 |
| Requesting food | 0.81 ± 1.06 | 0.00–4.00 |
| Noncompliance | 1.06 ± 1.41 | 0.00–6.33 |
| Child play | 7.63 ± 36.78 | 0.00–218.67 |
| Child eating | | |
| Bites | 62.51 ± 22.69 | 17.67–104.33 |
| Sips | 7.83 ± 4.77 | 0.00–24.33 |
| No plate | 0.89 ± 3.25 | 0.00–18.67 |
| Spit-out | 0.24 ± 0.42 | 0.00–1.67 |

sistent with hypothesis 2, children who were disruptive during meals had poorer average daily blood glucose levels. These analyses found that children who were noncompliant with parental commands to eat ($r = 0.55$, $P < 0.01$) and who tended to be away from the table ($r = 0.61$, $P < 0.01$) had higher average daily levels. A statistical trend was found between children who spit out food and children's average daily levels ($r = 0.38$, $P = 0.02$). Contrary to expectations, no relationships were found between child refusals and children's dietary adherence or average blood glucose levels. Also, no relationships were found between children's mealtime behaviors and their average calorie intake at meals.

### Parent's mealtime behaviors and children's health outcomes

Next, analyses sought to test hypotheses 3 and 4, which pertained to parent mealtime behaviors. Consistent with hypothesis 3, correlations were found between the number of carbohydrate units deleted from children's meals and parents' use of coaxing ($r = 0.80$, $P < 0.01$) and interrupted commands to eat ($r = 0.64$, $P < 0.01$). In addition, a significant correlation was found between the number of carbohydrate units deleted from children's meals and parents' perceptions of child behavior problems ($r = 0.52$, $P < 0.01$). Consistent with hypothesis 4, significant correlations were found between parents' use of ineffective/coercive parenting strategies at mealtimes and children's average daily blood glucose levels: coaxes ($r = 0.58$, $P < 0.01$), interrupted commands ($r = 0.66$, $P < 0.01$), and physical prompts ($r = 0.45$, $P = 0.01$).

**CONCLUSIONS** — Previous research has found no differences in mealtime behaviors for young children with type 1 diabetes, despite parents' perceptions of mealtime behavior problems (8,9). No study has examined the relationships between mealtime behaviors in young children with type 1 diabetes and health outcome variables, such as dietary adherence and glycemic control.

Results from this prospective study of mealtime behaviors in families of young children with type 1 diabetes found significant correlations between several disruptive child mealtime behaviors and children's dietary adherence and average blood glucose control. Similarly, significant correlations were found between several coercive/ineffective parenting strategies and children's dietary adherence and average blood glucose control.

Specific child and parent mealtime behaviors examined in this study were selected based on research and behavioral theory related to parent-child feeding interactions (7,13,15). As a measure of disruptive child behaviors, we examined children's frequency of leaving the table during mealtimes, refusing parental commands to eat, refusing or complaining about foods, and spitting out foods. Our previous work in families of young children with type 1 diabetes has demonstrated that parents commonly report problems with children leaving the table at mealtimes and complaining during meals (8). These behaviors are disruptive primarily because they inhibit optimal food intake and can prolong mealtimes. Similarly, children who spit out their food may not eat enough at mealtimes or may render their food inedible, which in the long run may force parents to make alternative meals or provide their child with a snack after the meal.

With respect to parent behaviors, we defined ineffective/coercive parenting strategies as coaxing, interrupted commands, physical prompts, and feeds. Coaxing is a common feeding strategy used by parents of young children (8,9,13). This strategy is inherently ineffective because it is a passive technique that does not provide children with a clear message of the behaviors expected of them and the consequences of noncompliance. Likewise, interrupted commands are ineffective because they do not give children opportunity to comply with parental commands and to learn the cause and effect relationship of compliance during a mealtime. The use of physical prompts (i.e., loading food onto the child's fork) and feeds are coercive because they can undermine the child's independence during the meal, which may promote disruptive behavior.

Other problematic child and parent behaviors that were not assessed in this study include subtle disruptive behaviors, such as how readily children come to mealtimes, drinking rather than eating, the length of time between children's bites, and parents' use of threats to control mealtimes (8). Future research is needed to examine these behaviors within the context of family mealtime interactions in young children with type 1 diabetes and to examine their relationships with children's health outcomes.

This is the first study to consider the potential health implications of common disruptive child mealtime behaviors in young children with type 1 diabetes. Developmental challenges of the young childhood period can present many unique mealtime challenges for families, regardless of children's chronic illness status (7). In this period, children must learn to follow a structured feeding schedule. In addition, neophobia and unpredictable

changes in children's food preference and/or intake are common (7). Because of the potential health implications of poor parent-child mealtime interactions in families of young children with type 1 diabetes, it is likely that these families may benefit from behavioral-based interventions to improve mealtimes. Within the behavioral science literature, research has demonstrated that common disruptive child behaviors can be effectively reduced by establishing specific rules and consequences for mealtimes and teaching parents behavioral strategies for meals (16).

We report on the relationships between mealtime behaviors and children's dietary adherence and blood glucose control in a sample of young children with type 1 diabetes. During recruitment, all eligible families were invited to participate, and the first 35 families to consent to the study were enrolled. The entire recruitment phase for this project lasted ~18 months. This allowed us to recruit some families who did not come to the clinic often. Despite this, the families who participated in this study were primarily white, married, and from the middle to upper-middle class. Although this sample was representative of the patient population and communities from which it was drawn, the findings of this study may not generalize to more diverse patient populations. Similarly, because the majority of children followed a conventional insulin regimen of two to three shots per day, the findings of this study may not generalize to all young children with type 1 diabetes. Within the U.S., it is not known how many young children with type 1 diabetes use some form of intensive insulin therapy, but the literature suggests that this is becoming the standard of care for children. Because intensive insulin management allows patients greater control in their daily insulin levels, there are no prescribed carbohydrate requirements for meals. However, these children still need to maintain blood glucose levels that approximate the normal range. Therefore, the finding that children's disruptive mealtime behaviors relate to higher average blood glucose levels underscores the need to examine mealtimes in these families and to develop interventions that promote better mealtime interactions. Finally, this study used both a direct observation technique and a behavioral questionnaire to assess mealtime behaviors. Although comparisons of the mean mealtime behaviors for the present study and published means for similarly aged children with type 1 diabetes and control children suggested no differences in the mealtime functioning of parents and children, a selection bias may have occurred, with only parents who have concerns about mealtimes consenting to participate. Future research examining mealtime interactions may consider using a questionnaire to screen families about their perceptions of mealtimes and to examine these relationships separately for families who report a lot of concern about mealtimes and those who report few concerns about mealtimes.

Although parents of young children with type 1 diabetes perceive more mealtime behavior problems than parents of matched control subjects, our research has demonstrated no differences in mealtime behaviors (8,9). The results of the current study may offer some explanation for these differences. Findings of this study demonstrate that mealtime interactions in families of young children with type 1 diabetes relate to key health outcome variables, including children's dietary adherence and average blood glucose control. Future research should attempt to replicate these relationships in a larger and more diverse sample, develop interventions to help parents of young children with type 1 diabetes effectively manage mealtime behaviors, and examine children's glycemic control from a multifactorial perspective including children's mealtime behaviors, food choices, insulin behaviors, and families' psychosocial functioning.

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