

Caloric Intake and Eating Behavior in Infants and Toddlers With Cystic Fibrosis

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ABSTRACT. *Objective.* Infants and toddlers with cystic fibrosis (CF) are at risk for poor growth. Controlled behavioral assessment studies have not focused on this population. This study compared calorie intake, percentage of Recommended Daily Allowance (RDA) per day and per kilogram, and percentage of calories from fat, protein, and carbohydrates between infants and toddlers with CF and healthy peers. Also, eating behaviors, such as meal duration, bites and sips per minute, percentage of meal spent eating, children's problematic eating behaviors, and parents' perceptions of mealtime behaviors were compared between infants and toddlers with CF and controls. Five hypotheses were tested. 1) Infants and toddlers with CF would be comparable to controls on the number of calories consumed per day and the percentage of calories from fat. 2) Infants and toddlers with CF would not meet the CF dietary guidelines for the percentage of RDA for calories or the percentage of calories from fat. 3) Infants and toddlers with CF would have longer meal durations than healthy peers, but would not differ on the pace of eating, the number of calories consumed during the meal, or the percentage of time spent eating during the meal. 4) Parents of infants and toddlers with CF would perceive more problematic mealtime behavior than controls. 5) Parents' perceptions of children's mealtime behavior would positively correlate with meal duration and negatively correlate with the number of calories consumed during the meal.

Design. A 2-group comparison study.

Setting/Sample. A clinical sample of 35 infants and toddlers with CF ($M = 18.6$; standard deviation = 8.1 months; range = 7–35 months) and a community sample of 34 healthy peers matched for age, gender, socioeconomic status, and number of parents and siblings present during mealtimes.

Measurement and Main Results. Children's calorie intake was measured using 3-day diet diaries. The 2 groups did not differ on the total number of calories consumed per day, the percentage of calories derived from fat, or the percentage of RDA consumed per day. Infants and toddlers with CF were not meeting the CF dietary recom-

mendations of 120% to 150% RDA for energy with 40% of calories coming from fat. Using the Dyadic Interaction Nomenclature for Eating, a behavioral coding system, videotaped recordings of children's dinner meals were scored for meal duration, number of bites and sips per minute, number of calories per bite or sip, and the percentage of 10-second intervals with bites and sips. The CF sample had significantly longer mealtimes (20.2 minutes) than the control group (16.4 minutes), but did not differ on calories consumed at the meal, bites and sips per minute, calories per bite and sip, or time spent eating during the meal. On the Behavioral Pediatrics Feeding Assessment Scale, a measure of parental perceptions of mealtime behavior that was completed by a subset of families (39 families), parents of infants and toddlers with CF endorsed a greater number of mealtime behaviors as problems and a higher occurrence of problems than did parents of controls. Examples of these behaviors for the CF sample included problems with their child's willingness to try new foods (48%), eat vegetables (48%), and observations that their child has a poor appetite (32%) and would rather drink than eat (32%). Parents of children with CF chose a greater number of mealtime strategies and feelings as problems and reported more frequently using problematic strategies at mealtimes than did parents of controls. Examples of problematic strategies and feelings for parents of infants and toddlers with CF included feeling anxious/frustrated when feeding their children (37%), not feeling confident that their child eats enough (32%), and using coaxing to get their child to take a bite (26%). For the entire sample, a positive correlation of 0.29 was found between the number of mealtime behavior problems reported by parents and meal duration, suggesting the co-occurrence of problematic mealtime behavior with longer meal duration. No relationship was found between the number of child mealtime behavior problems reported by parents and the number of calories consumed during the filmed meal. For the CF sample, a correlation of -0.26 between children's weight percentile for age and the filmed meal duration was found, suggesting a tendency for meal duration to increase as children's weight for age decreases. Post-hoc analyses were conducted comparing infants and toddlers with previously reported samples of preschool and school-aged children on meal duration. Results demonstrated that in each group, children with CF had longer meals than age-matched controls.

Conclusions. Our findings reveal significant deficits in achieving dietary recommendations for many families of infants and toddlers with CF. Only 11% of infants and toddlers with CF met the CF dietary recommendation of at least 120% of the RDA/day for energy. In addition, infants and toddlers were found to derive only 34% of their daily calories from fat, compared with the recommended 40% needed for a moderate to high fat diet.

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These results underscore the need for intervention in families of infants and toddlers with CF, who in addition to being at increased risk for malnutrition, may also experience a hastening in the decline of their pulmonary status because of poor nutritional status. Currently, there is limited programmatic research on nutritional and feeding interventions for toddlers and infants with CF. One study, which used a hospital-based behavioral education program to increase the caloric intake of 3 children (ages 10–20 months) who were below the fifth percentile for weight for length, found at least a 54% increase in calories for each child after treatment. Similarly, preliminary findings of 2 parent-based interventions, a nutrition education curriculum and a nutrition education plus behavior parent-training curriculum, found a 22% and 32% increase in daily calories, respectively, at treatment completion. A large-scale clinical trial is needed to evaluate the efficacy of any nutritional intervention before widespread dissemination. Additional assessment-focused research is also needed to identify patients' who may be at greatest risk for malnutrition and to guide the development of interventions to treat them. *Pediatrics* 2002; 109(5). URL: <http://www.pediatrics.org/cgi/content/full/109/5/e75>; nutrition, chronic illness, dietary adherence, parenting, pediatric psychology.

ABBREVIATIONS. CF, cystic fibrosis; RDA, Recommended Daily Allowance; SD, standard deviation; SES, socioeconomic status; BPFAS, Behavioral Pediatrics Feeding Assessment Scale.

Families of children with cystic fibrosis (CF) are challenged with dietary demands that necessitate that children consume 120% to 150% of the Recommended Daily Allowance (RDA) for energy with 40% of calories coming from fat.^{1–4} These recommendations are based on a need to compensate for an energy imbalance related to disease factors including frequent respiratory infections, the malabsorption of dietary fat, and a higher metabolic rate.⁵ Although dietary recommendations for patients with CF have been prescribed for at least 2 decades, many patients and their families are poorly adherent to these guidelines.^{6,7} Epidemiologic reports suggest that approximately 50% of patients with CF are below the 10th percentile for weight, height, or both.⁸ Inadequate nutritional intake results in malnutrition, which is correlated with pulmonary progression and premature morbidity for patients with CF.⁹ These findings underscore the importance of optimal nutritional intake for children with CF to promote growth and improve long-term health outcomes.¹⁰

A few studies have investigated the caloric intake and growth of preschool and school-aged children with CF.^{4,11,12} These studies demonstrate a tendency for children with CF to consume a higher percentage of the RDA than children without CF but to be smaller in size than age-matched children without CF. Furthermore, the children with CF did not consume the recommended 120% to 150% RDA for calories, nor did they consume 40% of calories from fat.^{4,11,12} Mealtime behavior problems may be 1 factor contributing to families' limited compliance with CF dietary recommendations.¹³

Parents of children with CF commonly report mealtime behavior problems, including poor appe-

tite, avoiding eating by talking, and spitting out food.^{14–16} In fact, relative to parents of age-matched, nonchronically ill children and parents of children with other chronic illnesses (eg, sickle cell disease and cancer), parents of children with CF report more problematic mealtime behaviors in their children.^{16,17} These mealtime behavior problems may inhibit children's caloric intake at meals. Crist et al¹⁴ found a negative correlation between children's caloric intake and the number of problematic mealtime behaviors identified by parents, suggesting families reporting more mealtime problems have children who are consuming fewer calories at meals.

Related to mealtime behavior problems, environmental factors such as children's eating style, may contribute to families' adherence to CF dietary recommendations. Research has demonstrated that meal duration and eating behaviors, such as the number of bites per minute and the percentage of the meal spent eating, may discriminate between school-aged children and preschoolers with CF and children without CF.^{11,12} Using data collected from videotaped observations of family dinners, Stark et al¹² found that school-aged children with CF had significantly longer meal durations than age-matched healthy control children. Additional analyses revealed that children with CF spent a smaller percentage of the mealtime eating than control children (mean = 43% of the meal for children with CF vs 51% for control children). There was also a statistical trend noted for the number of bites consumed per minute, with school-aged children with CF taking fewer bites per minute (mean = 3.50) than control children (mean = 4.13). Analyses of group differences in preschool-aged children with CF compared with age-matched controls similarly revealed a difference in dinner meal duration, with children with CF having longer mealtimes than control children. However, there were no significant group differences in the percentage of time preschoolers spent eating and the number of bites consumed per minute.¹¹ In sum, the data from these cross-sectional studies suggest that families of children with CF face some common mealtime challenges and that without intervention, these challenges may intensify with age. Research focusing on the nutritional intake and feeding behavior of infants and toddlers with CF compared with healthy control children is an important next step in understanding the developmental progression of eating and mealtime behaviors in children with CF. This research will provide data on how best to intervene with families of children with CF to prevent the emergence of disruptive mealtime behaviors and promote optimal dietary adherence.

PURPOSE

The present study extends previous research on nutrient intake and eating behaviors of preschool-aged and school-aged children with CF to infants and toddlers with CF. Specifically, this study assessed infants' and toddlers' calorie intake, including the percentage of calories from fat, protein, and carbohydrates and compared these values with infants and toddlers without CF. In addition, eating behav-

iors, such as meal duration, bites and sips per minute, percentage of meal spent eating, children's problematic eating behaviors, and parents' perceptions of mealtime behaviors were compared between infants and toddlers with CF and control infants and toddlers. Consistent with our previous research with preschool-aged children with CF, we proposed 5 hypotheses. 1) Infants and toddlers with CF would be comparable to children without CF on the number of calories consumed per day and the percentage of calories from fat. 2) Infants and toddlers with CF would not meet the CF dietary guidelines for the percentage of RDA for calories or the percentage of calories from fat. 3) Infants and toddlers with CF would have longer meal durations than healthy peers, but would not differ on the pace of eating, the number of calories consumed during the meal, or the percentage of time spent eating during the meal. 4) Parents of infants and toddlers with CF would perceive more problematic mealtime behavior than parents of infants and toddlers without CF. 5) Parents' perceptions of children's mealtime behavior would positively correlate with meal duration and negatively correlate with the number of calories consumed during a filmed meal.

METHODS

Participants

CF

Thirty-five infants and toddlers with CF and their parents were recruited from the CF centers at Cincinnati Children's Hospital Medical Center, Dayton Children's Medical Center, Rhode Island Hospital, and the University of California, San Diego Medical Center. Children ranged in age from 7 to 35 months, with a mean age of 18.6 months (standard deviation [SD]: 8.1). The sample consisted of 17 boys and 18 girls. All of the children were white, and 33 (94%) lived in 2-parent households. Family's socioeconomic status (SES) was determined by the Hollingshead 4-Factor Index,¹⁸ with 6% of families falling in the second strata, 20% in the third strata, 48% in the fourth SES strata, and 26% in the fifth (and highest) SES strata. The weight percentile for age for children with CF ranged from below the 5th percentile to the 99th percentile (mean: 43.1; SD: 31.5). Their height percentile for age ranged from below the 5th percentile to the 97th percentile (mean: 36; SD: 28). Children's mean weight percentile for height was 53 (SD: 30.6; range: 3.1–99.8). Also, 4 infants and toddlers with CF were at or below the 10th percentile for weight for height. All participants with CF were pancreatic insufficient and on nonrestricted fat diets. Parents of infants and toddlers with CF received standard nutritional instructions from the clinic dietician, which recommended increased calories and fat. None of the infants and toddlers with CF who participated in this project was receiving nutritional supplements or intensive nutritional counseling at the time of assessment.

Controls

Thirty-four nonchronically ill infants and toddlers were recruited to provide a comparison sample. Control children were matched to infants and toddlers with CF on age, gender, SES (within 1 category), and number of parents and siblings present during mealtimes. Children in the control group ranged in age from 7 months to 35 months ($M = 18.4$; $SD: 7.5$) and were 50% male. Family's SES was distributed across SES strata, with 3% of families falling in the second strata, 6% in the third strata, 41% in the fourth strata, and 50% falling in the fifth SES strata. Control children were predominantly white (97%) and from households with 2 parents (97%). Infants and toddlers in the control group ranged in weight percentile for age from the 8th percentile to 96th percentile (mean: 54.6; SD: 28.3). Their height percentile for age was between the 5th and 98th percentile (mean: 48; SD: 27.5).

Control children's mean weight percentile for height was 59.1 (SD: 24.6; range: 8.7–98.4). Only 1 healthy control infant was below the 10th percentile for weight for height. There were no differences between the groups on demographic variables. Table 1 presents a summary of the demographic characteristics of the CF and control samples.

To assess differences attributable to geographic location (East Coast, West Coast, or Midwest), children were compared on demographic information. χ^2 analyses demonstrated no significant differences between geographic sites for children's SES, χ^2 ($N = 69$) = 14.95; $P = .09$, children's ethnicity, χ^2 ($N = 74$) = .91; $P = .82$, or parents' marital status, χ^2 ($N = 74$) = 1.31; $P = .34$. One-way analysis of variance revealed a significant site difference for children's age ($F[3,70] = 7.70$; $P = .001$), with the Midwest site recruiting older toddlers (mean age = 24.8 months) than the East and West Coast sites (mean age = 13.6 months and 15.5 months, respectively). However, when compared within geographical sites, there were no significant age differences between infants and toddlers with CF and controls.

Procedure

Child Recruitment

Similar to the recruitment procedures used in previous research with older children with CF,^{11,12} infants and toddlers with CF and their families were initially contacted by letter from the clinic director and the principal investigator. Approximately 1 week after the letters were mailed, families were phoned by a member of the research team to describe the study in detail and enroll participants. For families who agreed to participate, an initial home meeting was scheduled to collect informed consent and to administer dependent measures. Families in the control sample were recruited following a similar procedure from community pediatricians' offices, child care centers, newspaper articles, and media announcements. Approval of the study protocol and informed consent form was obtained from the institutional review board at each of the study sites before subject recruitment.

TABLE 1. Demographics and Anthropometrics

Variable	CF (N = 35)		Control (N = 34)	
	M	SD	M	SD
Age (mo)	18.6	8.1	18.4	7.5
Weight percentile for age	43.1	31.5	54.6	28.3
Height percentile for age	36.0	28.0	48.0	27.5
Weight percentile for height	53.0	30.6	59.1	24.6
Weight-for-age z score	-0.18	1.60	0.18	0.89
Height-for-age z score*	-0.57	1.25	-0.01	0.94
Weight-for-height z score	0.33	1.81	0.32	0.80
	Frequency	%	Frequency	%
Gender				
Male	17	48.6	17	50.0
Female	18	51.4	17	50.0
Race				
Black	0	0	1	3.0
White	35	100.0	33	97.0
SES factor score (Hollingshead Scale)†				
I	0	0	0	0
II	2	5.7	1	2.9
III	7	20.0	2	5.9
IV	17	48.6	14	41.2
V	9	25.7	17	50.0
Family marital status				
Married	33	94.2	33	97.0
Not married	2	5.8	1	3.0

* $P = .04$. All other statistical comparisons among demographic and anthropometric data are nonsignificant.

† The Hollingshead 4-Factor Scale is measured from I (lowest level) to V (highest level).

Home Visits

At least 3 home visits were scheduled with each family to collect dependent measures. These visits were scheduled at the family's convenience and to coincide with a meal (either lunch or dinner, with at least 1 meal being dinner). For each home visit, the research assistant arrived approximately 30 minutes to 1 hour before the family's typical mealtime. On arrival, a video camera was set up to record the meal. During the actual filming of the meals the research assistant waited in a separate room or outside of the house. Meals were judged as "representative" if parents rated the target child's behavior, child's food intake, and the family interaction as "similar" or "very similar" to the normal mealtime routine. During the first home visit, parents signed the consent form, completed questionnaires, and were taught to keep a weighed 3-day diet diary to monitor their child's food intake. Parents were supplied with food scales, measuring cups, and detailed written instructions for weighing foods and recording their child's mealtime intake. During subsequent home visits, the research assistant reviewed the parents' diet diaries and meals were videotaped. Families received a small monetary compensation for their participation in the study.

Dependent Measures

Weight and Height

Children's weight and height were recorded within 1 week of study entry by trained research personnel using a standardized measurement protocol. Measurements were obtained either at the first home visit or during a visit to the medical center. Children were weighed without a diaper and without shoes using either a stationary or portable digital scale (Scale Tronix, Wheaton, IL; SECA Model 815, Columbia, MD). Children were weighed a minimum of 2 times or until their weight was within 0.2 kg on 2 consecutive attempts. Children's height or length was measured in centimeters using either a stationary or portable stadiometer (Holtain, Crymych, England; Shorr Products, Woonsocket, RI). Children were measured in street clothes and without shoes a minimum of 4 times, and the mode height was recorded. Children's weight and height percentiles were derived using Centers for Disease Control and Prevention (Atlanta, GA) anthropometric software program version 3.1.

Diet Diaries

Children's calorie intake was measured using 3-day diet diaries. Three-day diet diaries were selected for this study because they are less labor-intensive for families and have been shown to be representative of calorie intake over a 7-day period.^{19,20} Family's diet diaries were analyzed using the Minnesota Nutrition Program, a nutritional software program. Information was obtained on total calorie intake and the percentage of calories from carbohydrates, fat, and protein.

Dinner Diaries

In addition to 3-day diet diaries, parents were asked to record all foods and liquids consumed by their child at videotaped meals. These data were similarly analyzed using the Minnesota software program. All diet diary data were reviewed for accuracy by a licensed registered dietician and compared with the 1989 RDA for energy.²¹

Videotape Data

Using a behavioral coding system reported by Stark et al (Dyadic Interaction Nomenclature for Eating),^{11,12} videotaped recordings of children's dinner meals were scored for meal duration, number of bites and sips per minute, number of calories per bite or sip, and the percentage of 10-second intervals with bites and sips. A primary observer who was blind to children's group status (ie, CF or control) scored 1 videotaped dinner meal for each child. Interrater reliability was assessed using a subset of the videotapes (30%), which were scored independently by a second observer. Kappa statistics were calculated on the agreement of number of bites and sips within each 10-second interval. The average kappa for bites was 0.81 (range: 0.60–0.96) and 0.93 (range: 0.64–0.99) for sips. Approximate calories per bite and sip was calculated by dividing total food calories by the total number of bites and sips during each meal. The percentage of time spent eating during the

meal was calculated by dividing the number of intervals in which a bite and/or a sip was coded by the total number of 10-second intervals per meal.

Behavioral Pediatrics Feeding Assessment Scale (BPFAS)

Parent report of children's mealtime behavior was assessed using the BPFAS.²² This measure was completed by 39 families who were recruited from the Midwest site, representing 56% of the sample. The BPFAS is a 35-item questionnaire that examines parent and child behaviors associated with poor nutritional intake. The first 25 items focus specifically on child behaviors, and the last 10 items focus on parents' feelings or strategies for managing mealtime behaviors. For each item, parents were instructed to indicate the frequency of the behavior using a Likert scale (1 = "never" to 5 = "always"). In addition, using a yes/no format, parents were asked to indicate whether the particular behavior is a problem for the family. Items are phrased in both the positive (eg, "my child will try new foods") and negative (eg, "my child whines or cries at feeding time") directions, with positively phrased items reversed scored in the final calculation. This scale yields 4 scores: Child Behavior—Frequency (ie, sum of 5-point Likert scores; range: 25–125), Child Behavior—Problems (ie, number of behaviors rated yes; range: 0–25), Parents' Feelings/Strategies—Frequency (ie, sum of 5-point Likert scores; range: 10–50), Parents' Feelings/Strategies—Problems (ie, number of behaviors rated yes; range: 0–10). Frequency scores reflect how often parent and child behaviors occur. Problem scores reflect the number of behaviors the parents' consider to be feeding problems. Higher scores are suggestive of maladaptive feeding behaviors as well as problematic parental strategies for managing mealtime behavior. Some examples of child behaviors include: "chokes or gags at mealtime," "takes longer than 20 minutes to finish a meal," and "eats junky snack food but will not eat at mealtimes." Examples of parental mealtime management strategies are "I coax my child to get him/her to take a bite," "If my child doesn't like what is served, I make something else," and "I use threats to get my child to eat."

The BPFAS was developed to measure mealtime behaviors in young children (ages 9 months–7 years). It has been used in previous research with children with CF and healthy children.^{14,22,23} Psychometric analyses suggest that the BPFAS has adequate internal consistency for the behavior domains and the measure as a whole ($\alpha = 0.74$ – 0.88). The test-retest reliability coefficients (0.82–0.85) measured over a 2-year interval suggest the stability of this assessment measure.²²

Data Analyses

Power Analysis

A power analysis was performed before subject recruitment. Whenever possible, research comparing children with CF to non-chronically ill children was used. If these data were not available, comparisons of young children with or without persistent eating problems were used. A review of previous research demonstrated medium to large effect sizes for meal duration,¹¹ calorie intake,²⁴ and mealtime behaviors.²² A power analysis was performed assuming a sample size of at least 30 subjects in each group, an α level of 0.05 for testing a 1-tailed hypothesis, and a power of at least 80%. These analyses revealed that the current sample size was adequate to find significant group differences for the outcome variables.

Statistical Analyses

Infants and toddlers with CF were compared with a sample of children without chronic illness on anthropometric measurements, calorie intake, percentage of calories from fat, protein, and carbohydrates, and percentage of RDA for energy using a series of independent sample *t* tests. Although families were given the option of videotaping both lunch and dinner meals, to be consistent with the methodology of previously reported data,^{11,12} we selected only dinner meals for the current analyses. A total of 158 dinner meals were obtained for the study with every child having at least 1 dinner meal recorded. A repeated measures analysis of variance with dinner meals (eg, meals 1, 2, 3) as the within-subject factor and child's group status (CF vs control) as the between-subjects factor revealed a significant main effect for group status ($F[1,39] = 4.15$; $P = .049$), with infants and toddlers with CF taking

longer to eat at dinner than control children. No within-subject differences in meal duration were found, suggesting meal duration was not different across the sampled meals. Because there was no within-subject difference for meal duration, we randomly selected a dinner meal for each subject to evaluate children's pace of eating. Specifically, this study assessed: number of bites and sips per minute, number of calories per food intake (ie, bite or sip), and the percentage of intervals with bites or sips (ie, a measure of time spent eating during the meal). These variables were compared by sample using *t* tests for independent samples. Parents' perceptions of mealtime behaviors were compared by sample using 2 multivariate analysis of variance tests evaluating child and parent behaviors separately. Finally, Pearson product-moment correlations were conducted to evaluate the relationships between meal duration, reported behavioral problems on the BPFAS, and children's calorie intake for the randomly selected, filmed dinner meal.

RESULTS

Anthropometric Measures

Infants and toddlers with CF were compared with same-age peers without CF on measures of height, weight, weight percentile for age, and weight-for-height percentile using a series of independent sample *t* tests. *z* Scores for weight, height, and weight-for-height were also compared. These analyses revealed no significant differences between the 2 groups on height ($t[67] = -0.87$; $P = .38$) (CF mean = 79.2 cm, control mean = 80.9 cm), weight ($t[67] = -0.81$; $P = .42$) (CF mean = 10.9 kg, control mean = 11.3 kg), weight percentile for age ($t[67] = -1.6$; $P = .12$) (CF mean = 43.1 percentile, control mean = 54.6 percentile), and weight-for-height percentile ($t[67] = 0.91$; $P = .37$) (CF mean = 53 percentile, control mean = 59.1 percentile). For *z* scores, there were no differences for weight-for-age *z* score ($t[67] = 1.11$; $P = .27$) (CF mean = -0.18 , control mean = 0.18) or weight-for-height *z* score ($t[67] = -.06$; $P = .96$) (CF mean = 0.33 , control mean = 0.32). The comparison of height-for-age *z* score yielded a significant difference, with the control group greater than the CF group ($t[67] = 2.11$; $P = .04$) (CF mean = -0.57 , control mean = -0.01).

Nutritional Intake and RDA Comparisons

A comparison of average daily food intake obtained from 3-day diet records was conducted using a *t* test for independent samples (Table 2). These analyses demonstrated no differences between the 2 groups on average daily calories consumed ($t[67] = -1.24$; $P = .22$). The 2 groups differed when compared for calories consumed per kilogram of body weight ($t[67] = 2.50$; $P = .02$), with infants and toddlers with CF consuming more calories per kilogram than control infants and toddlers ($M = 102.8$, $SD = 25.0$; and $M = 88.2$, $SD = 23.6$, respectively). Children's caloric consumption was also compared by

percent of RDA for energy. For these analyses, we examined both the percentage of RDA consumed per day (RDA/d) and the percentage of RDA consumed per kilogram of body weight (RDA/kg) for each of the 2 groups. The percentage of RDA/d was based on the nutritional standard of 1300 calories per day for children ages 1 to 3 years.²¹ This value provides a measure of children's energy intake compared with the guidelines for healthy children of similar age and is consistent with the nutritional consensus report for patients with CF.²⁴ The percentage of RDA/kg was based on the nutritional standard of 102 kilocalories per kilogram of body weight for children ages 1 to 3 years²¹ and provides a calorie recommendation that is tailored to the individual size of the child. A trend toward significance was revealed when analyzed according to the percentage of RDA/d ($t[67] = -1.97$; $P = .052$), with infants and toddlers with CF consuming a slightly greater percentage of RDA/d (92% of the RDA/d) than control infants and toddlers (81% of the RDA/d). A significant difference was found for the percentage of RDA/kg consumed by infants and toddlers ($t[67] = 2.50$; $P = .015$). Infants and toddlers with CF consumed a mean of 103% of the RDA/kg compared with control infants and toddlers who consumed a mean of 88% of the RDA/kg. Table 3 presents the range of RDA for energy for children in each group.

Three-day diet records were analyzed according to the percent of calories derived from fat, protein, and carbohydrates. Table 2 presents the mean percentages of calories from fat, protein, and carbohydrates consumed by infants and toddlers in each group. A series of *t* tests for independent samples indicated no group differences between infants and toddlers with CF and infants and toddlers without CF for average percentage of calories from fat ($t[67] = -0.51$; $P = .61$), protein ($t[67] = 1.31$; $P = .19$), and carbohydrates ($t[67] = -0.23$; $P = .82$).

Meal Duration and Eating Behaviors

Because a priori analyses revealed no within-subject differences in average meal duration across filmed dinner meals, 1 filmed dinner meal was selected at random from each child to evaluate mealtime behaviors and the relationships between these behaviors and caloric intake. Calorie information for the selected meal was obtained from the corresponding meal record parents completed at the time of videotaping. The data were analyzed using independent sample *t* tests for the following mealtime behaviors: number of bites per minute, number of sips per minute (accounting for bottle and cup feedings), number of calories per food intake (ie, bite or sip),

TABLE 2. Average Daily Calorie Intake and Percentage of Calories Derived From Fat, Carbohydrates, and Protein

	CF Group			Control Group		<i>t</i> (<i>df</i>)	<i>P</i>
	Mean	(SD)		Mean	(SD)		
Total calories	1090.2	(283.4)	Total calories	1000.2	(320.0)	-1.24 (67)	.22
% Fat	33.8	(6.2)	% Fat	33.2	(6.2)	-0.51 (67)	.61
% Carbohydrate	55.8	(8.3)	% Carbohydrate	55.1	(8.6)	-0.23 (67)	.82
% Protein	12.4	(3.2)	% Protein	13.4	(3.0)	1.31 (67)	.19

TABLE 3. Percent RDA for Energy

	CF Group					Control Group				<i>t</i> (<i>df</i>)	<i>P</i>
	Minimum	Maximum	Mean	(SD)		Minimum	Maximum	Mean	(SD)		
% RDA (kcal/d)*	46.0	149.2	92.1	(22.9)	% RDA (kcal/d)	43.5	158.5	81.1	(23.4)	-1.97 (67)	.052
% RDA (kcal/kg)	58.1	166.3	103.2	(25.5)	% RDA (kcal/kg)	52.7	174.3	88.3	(23.4)	-2.52 (67)	.015

* Based upon standard of 1300 calories per day for children ages 1 to 3 years.

and the percentage of time spent eating. In addition, the groups were compared on the number of calories consumed during the meal.

Similar to the outcome of the group comparison of all dinner meals, a significant group difference (CF versus control) was found in meal duration for the selected dinner meal, with infants and toddlers with CF taking longer to eat at this meal than age-matched healthy controls ($t[65] = -2.21$; $P = .03$) (CF: $M = 20.2$ minutes [SD = 7.3] and control: $M = 16.4$ minutes [SD = 6.2]). A t test comparing calories consumed by group found no significant differences ($t[65] = -1.54$; $P = .13$). For mealtime behaviors, no significant group differences were found in the pace of children’s eating as measured by the average number of bites per minute ($t[65] = -0.11$; $P = .91$), the number of sips per minute ($t[62] = .002$; $P = .99$) and the percentage of 10-second intervals during the meal in which children were eating ($t[66] = .09$; $P = .92$). Similarly, infants and toddlers with CF did not differ from matched peers with regards to the number of calories consumed per food intake at dinner ($t[58] = -0.95$, $P = .34$).

Although group differences in eating behaviors were not found, additional analyses examined the relationships between weight percentile for age, meal duration, and eating behaviors within the infant and toddler CF sample ($N = 33$). These posthoc analyses found a Pearson product-moment correlation of -0.26 between children’s weight percentile for age and the filmed meal duration, suggesting a tendency for meal duration to increase as children’s weight for age decreases. No significant relationship was found between children’s weight percentile for age and the percentage of 10-second intervals in which children were eating. Similarly, no relationship was found between children’s weight percentile for age and the number of bites or sips taken per minute. A significant positive correlation of $.30$ ($P = .04$) was found between weight percentile for age and the number of calories consumed per food intake. This finding may reflect the co-occurrence of larger bites or the presentation of higher calorie meals in children who have a higher weight percentile for age.

The BPFAS was reviewed as a second measure of mealtime behavior. This scale was analyzed using 2 multivariate analysis of variance tests that separately examined group differences (CF versus control) in parents’ perceptions of child and parent mealtime behaviors (dependent measures). Results of these analyses revealed significant group differences for both child ($F[2,38] = 3.23$; $P = .05$) and parent ($F[2,38] = 3.8$; $P = .03$) behaviors. Separate 1-way analysis of variance tests indicated significant group

differences for the number of child problems reported by parents ($P = .02$), the occurrence of mealtime behavior problems ($P = .02$), the number of parent problems at mealtimes ($P = .02$), and the occurrence of mealtime behavior management problems for parents ($P = .02$). Overall, parents of infants and toddlers with CF identified a greater number of mealtime behaviors as problems and a higher occurrence of mealtime problems than parents of control infants and toddlers. Similarly, parents of infants and toddlers with CF reported using more problematic strategies for managing mealtime behaviors than parents of control infants and toddlers.

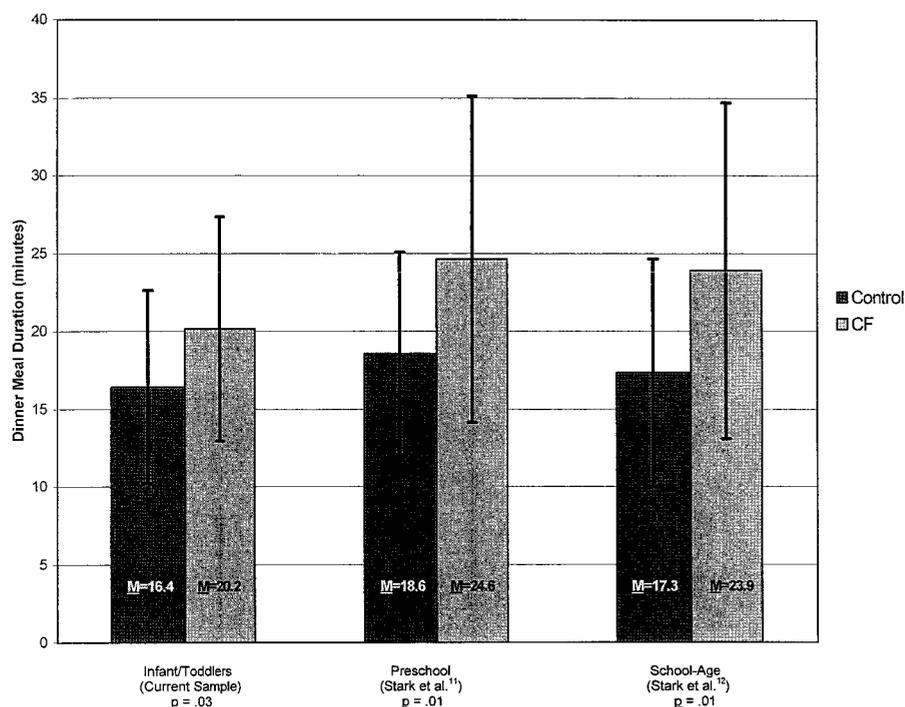
To identify specific mealtime behaviors that parents of infants and toddlers with CF endorsed as problematic, we examined the percent endorsed by parents for each behavior on the BPFAS. Parents of infants and toddlers with CF most often reported problems with their child’s willingness to try new foods (48%) and their willingness to eat vegetables (48%). It was also noted that many parents felt anxious/frustrated when feeding their children (37%). Several other commonly endorsed problems included: my child has a poor appetite (32%), my child would rather drink than eat (32%), parents use coaxing to get their child to take a bite (26%), and parents do not feel confident that their child eats enough (32%).

Pearson product-moment correlations were run with the combined sample (ie, infants and toddlers with CF and controls) to evaluate the relationships between children’s mealtime problem score and the meal duration and calories consumed during the filmed meal. A significant positive correlation of 0.29 ($P = .03$) was found between the number of child mealtime behavior problems and meal duration, suggesting the co-occurrence of problematic mealtime behavior with longer meal duration. No relationship was found between the number of child mealtime behavior problems and the number of calories consumed during the filmed meal.

Comparisons With Preschool- and School-Aged Children With CF

Posthoc analyses were conducted comparing infants and toddlers with previously reported samples of preschool and school-aged children on meal duration.^{11,12} Although these comparisons are not a longitudinal evaluation of changes in meal duration, the comparison of cross-sectional data by age group can provide a pattern of change for this variable.²⁵ Results demonstrated that in each age group, children with CF had longer meal durations than age-matched controls. Specifically, meal durations exceeded 20 minutes for children with CF. In contrast,

Fig 1. Pattern of meal duration across age groups.



average meal duration for control children across age groups remained below 20 minutes (Fig 1). Research with children with feeding disorders has found that the majority of calories consumed within a meal are eaten within 20 minutes and that increasing meal lengths may not increase the number of calories eaten by children.²⁶ Likewise, despite the observed difference in children's meal duration, our data demonstrated no difference between infants and toddlers with CF and control children with regards to the number of calories consumed during the meal, the number of bites and sips taken, and the percentage of the meal spent eating. Therefore, increasing meal duration seems an ineffective strategy for increasing children's caloric intake.

DISCUSSION

The present study extends the findings of previous research on the calorie intake and eating behaviors of preschool and school-aged children with CF to infants and toddlers with CF. Similar to preschoolers with CF, infants and toddlers with CF in the present study were found to be comparable to children without CF with regards to average total daily calories consumed. Infants and toddlers with CF ate more calories than control infants and toddlers when analyzed for calories consumed per kilogram of body weight, a measure that is sensitive to patient's size. However, the infants and toddlers with CF still did not eat enough calories to satisfy their own growth goals. When compared for the percentage of RDA/d, there was a trend suggesting that infants and toddlers with CF consumed a higher percentage of RDA/d than healthy peers, but fell short of meeting the CF dietary recommendation of 120% to 150% of the RDA for energy. In fact, only 11% of infants and toddlers with CF in the present study were found to be consuming at least 120% of the RDA for energy.

This finding is striking, as previous research with preschool¹¹ and school-aged children¹² with CF found 20% and 53.5% of the samples to be consuming at least 120% of the RDA for energy, respectively. For parents of infants and toddlers with CF, this comparison suggests a failure to meet fundamental CF dietary recommendations during a critical period of child development.

In addition to falling short of the recommended 120% to 150% of the RDA for energy, infants and toddlers with CF did not achieve the recommended 40% of calories from fat.¹ Similar to previous research with older children with CF,^{4,11,12} the current sample of children was found to consume only 34% of calories from fat. The high caloric density of fat provides an efficient means for patients with CF to consume a higher number of calories. For parents of infants and toddlers with CF, the transition from formula to solids only may present a particular challenge. The toddler period is typically characterized by changing food interests and neophobia, which may complicate the selection of high fat foods and food additives for children with CF.²⁷ However, the tendency for all of the children in these age groups to consume fewer than 40% of calories from fat may also point to a knowledge deficit among parents of children with CF or the influence of media and popular culture, which promote a moderate to low-fat diet for the healthy population.

When compared with children without CF on growth variables, infants and toddlers with CF were comparable on weight, height, weight percentile for height, and weight-for-height z score. A notable subset of infants and toddlers with CF were at or below the 10th percentile for weight-for-height, which can be a sign of nutritional failure. Children's failure to attain an adequate weight and to meet the CF dietary recommendation of 120% to 150% of the RDA un-

derscore the importance of developing nutritional interventions for parents of infants and toddlers with CF.

The data on toddler's feeding behaviors also offer some interesting comparisons across age groups that can contribute to nutritional interventions for children with CF. Similar to the preschool- and school-aged samples of children with CF, infants and toddlers with CF in the present study took longer to eat at mealtimes than control infants and toddlers. The average dinner meal duration for the infants and toddlers in the present CF sample was 20.2 minutes compared with 16.4 minutes for the control children. The data examining children's eating behaviors (ie, bites and sips per minute and the percentage of time spent eating) during mealtimes were not different across groups. Thus, despite longer meals on average, infants and toddlers with CF in the current sample were found to eat at a similar rate as infants and toddlers without CF. Because the comparison of meal duration in each of the age groups suggests a trend with meal duration increasing with age for children with CF, intervening with families of infants and toddlers with CF may be instrumental in preventing longer meal durations and increased behavioral resistance at mealtimes as children grow older.

Within the CF sample a modest negative association was found between children's weight percentile for age and meal length. This relationship suggests that children with CF who are smaller may take longer at mealtimes than children with CF who have attained a higher weight percentile. There were no relationships between children's eating behaviors and their weight percentile, but children with a higher weight percentile tended to consume more calories per bite or sip. Because these analyses measure the co-occurrence of variables and cannot predict causation, it is likely that the observed relationships may be bi-directional with both biological and behavioral factors affecting children's nutritional status. Children who are underweight may experience a poor appetite related to their poor weight status, which in turn may prompt more mealtime resistance, longer meal duration, and lower calorie intake per meal. However, children who are underweight may also receive more pressure to eat from their parents, which may in turn fuel mealtime resistance and lead to long meal duration and lower calorie intake. Regardless of the cause of the relationship, the treatment implications suggest that children with CF may benefit from nutritional education to boost calorie intake and behavioral strategies to decrease meal duration.

There was a significant group difference for parents' perceptions of mealtime behaviors. Parents of infants and toddlers with CF invoked more mealtime behaviors as problems and reported a higher occurrence of mealtime problems than parents of infants and toddlers without CF. In addition, parents of infants and toddlers with CF reported more frequently using problematic strategies for managing mealtime behaviors than parents of control infants and toddlers. Because mealtimes offer the best opportunity for caloric intake, parents of infants and

toddlers with CF may have a lower threshold for mealtime behavior problems than parents of infants and toddlers without CF. Similarly, because of the nutritional demands of the CF diet, parents may feel a greater pressure to encourage their child to eat than parents of nonchronically ill infants and toddlers. It is noteworthy to mention that across the samples (CF and controls) there was a positive correlation between meal duration and parent's perceptions of problematic behavior at mealtimes. Although the current methodology does not allow for an evaluation of the direction of this relationship, a possible explanation may be that longer meal durations intensify children's mealtime behaviors, especially resistant behaviors, which may subsequently contribute to parents' perceptions of greater mealtime problems. Conversely, problematic behavior during meals may increase meal duration especially if these behaviors lead to more noneating behaviors and greater amounts of time between bites or sips. The treatment implications of the correlation are clear: parents can benefit from behavioral treatment that teaches them how to manage problematic behavior and set limits on meal duration.

Comparisons of the current data with the previously reported preschool and school-aged CF samples highlight an interesting trend. Although parents of infants, toddlers, and preschoolers with CF were found to identify more mealtime behavior problems than parents of age-matched controls, parents of school-aged children with CF reported a comparable number of mealtime problems.^{11,12} An evaluation of the nutritional intake of the school-aged sample may help to explain these findings. Unlike the toddler and preschool samples, the school-aged sample of children with CF was found to eat a higher number of calories each day than peers and to achieve a higher percentage of RDA than controls.¹² Because these children were closer to achieving their nutritional goals, it is possible parents' may have actually experienced fewer problems with children's mealtime behavior. However, alternative hypotheses may be that school-aged parents' tolerance of children's mealtime behaviors may be higher because of desensitization. Also, these parents may have felt more confident in their management of mealtime behaviors than parents of younger children, thus influencing their perception of their child's behaviors as behavior problems. Or, because of differences in RDA requirements across the age groups (ie, fewer calories per day to reach 100% of the RDA), parents of school-aged children with CF may perceive the 120% to 150% RDA goal as more easily attainable.

The observed trend, if accurate, has implications for behavioral treatment. Based on these data, it is likely the optimal time to intervene with families of children with CF may be in the infant and toddler years, because parents are concerned about mealtime behavior during these ages and parents of children with CF are beginning to report longer meal durations than healthy peers. Because slower eating is associated with increased feelings of satiety from small amounts of food,²⁸ longer meal durations may interfere with children's ability to eat sufficient cal-

ories to achieve their nutritional goals. Longer meal-times may also have the adverse effect of contributing to greater behavioral disruption, if children continue to resist eating and/or intensify in their avoidance behaviors. For these reasons, behavioral interventions during the toddler years may be key to teaching families strategies to manage mealtime behaviors, promote caloric intake, and decrease meal lengths.

Although the findings of the present study demonstrate a relationship between mealtime behavior and calorie intake in infants and toddlers with CF, the relatively small sample size and the inclusion of families who were mostly middle to upper SES and married are limitations of the current study and may reduce the generalizability of the findings. Parental report of children's food intake on 3-day diet diaries may also have been vulnerable to reporting bias. Because parents of children with CF may place more emphasis on their child's growth and nutrition than parents of healthy children, it is possible that the parents of infants and toddlers with CF in the present study may have overreported their child's food intake. Future research, including a longitudinal evaluation of children's eating behaviors, is needed to measure more accurately the dietary intake of children with CF and to evaluate the contribution of children's eating behaviors to caloric intake. In addition, behavioral factors, such as the parent-child interaction during the meal, may be an important variable to consider in these investigations, as these factors are related to mealtime behavior and are likely to affect the success of future nutritional interventions. Finally, information from families with a greater range of SES and more diversity in other contextual variables would enhance the applicability of nutrition and behavior assessment research to future intervention efforts.

CONCLUSION

The results of the current study reveal significant deficits in achieving dietary recommendations for many families of infants and toddlers with CF. Only 11% of infants and toddlers with CF met the CF dietary recommendation of at least 120% of the RDA/d for energy. In addition, infants and toddlers were found to derive only 34% of their daily calories from fat, compared with the recommended 40% needed for a moderate to high fat diet. These findings underscore the need for intervention in families of infants and toddlers with CF, who in addition to being at increased risk for malnutrition, may also experience a hastening in the decline of their pulmonary status because of poor nutritional status.^{10,29} Currently, there is limited programmatic research on nutritional and feeding interventions for infants and toddlers with CF. One published study,³⁰ which used a hospital-based behavioral education program to increase the caloric intake of 3 children (ages 10 months–20 months) who were below the fifth percentile for weight for length, found at least a 54% increase in calories for each child on treatment completion. Similarly, preliminary findings of 2 parent-based interventions, a nutrition education curricu-

lum and a nutrition education plus behavior parent-training curriculum, found a 22% and 32% increase in daily calories, respectively, at treatment completion.³¹ These 2 preliminary studies offer a basic framework when developing nutritional interventions for families of young children with CF. However, a large-scale clinical trial is needed to evaluate the efficacy of any nutritional intervention before widespread dissemination. Additional assessment-focused research is also needed to identify patients' who may be at greatest risk for malnutrition and to guide the development of interventions to treat them.

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