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Mealtime Problems Predict Outcome in Clinical Trial to Improve Nutrition in Children with CF

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Summary

Better growth and nutritional status is strongly associated with better pulmonary function and survival in children with CF. Behavioral intervention is an efficacious treatment approach for improving calorie intake and weight gain in children with CF; and recently has been shown to facilitate maintenance of daily energy intake at 120% of the healthy population over a 2 year period. However, no study to date has examined factors that predict outcome with behavior intervention to promote weight gain in CF. The objectives of this study were to examine the influence of nutritional status, mealtime behavior problems, and maternal depressive symptoms on calorie intake and weight gain following participation in a randomized trial to improve nutritional status in cystic fibrosis. Sixty-seven children, ages 4 to 12 years with cystic fibrosis participated in a clinical trial targeting calorie and weight increases. Participants completed baseline measures of mealtime behavior problems, maternal depression, and fat absorption, and baseline and post-treatment caloric intake and weight. Assignment to behavioral group (R^2 change = .17), lower frequency of mealtime behavior problems (R^2 change = .11) and higher maternal depression (R^2 change = .06) predicted greater calorie increase baseline to post-treatment. Assignment to behavioral group (R^2 change = .09), higher baseline weight (R^2 change = .10) and fat absorption (R^2 change = .02), and lower frequency of mealtime behavior problems (R^2 change = .06) predicted greater weight gain baseline to post-treatment. Less frequent mealtime behavior problems led to better calorie intake and weight gain in a 9 week clinical trial of behavior intervention and nutrition education to improve nutritional status in cystic fibrosis. The key implication from these findings is that early referral to behavioral intervention as soon as growth deficits become a concern will likely yield the best nutritional outcomes.

Keywords

cystic fibrosis; nutrition status; behavior therapy; nutrition education

Introduction

Better growth and nutritional status is strongly associated with better pulmonary function and survival in children with CF¹⁻³. However, less than half of the children with this disease in the United States meet the CF Foundations recommendations for a BMI $\geq$ 50th percentile⁴. Behavioral intervention is an efficacious treatment approach for improving calorie intake and weight gain in children with CF⁵⁻¹⁰; and recently has been shown to facilitate maintenance of daily energy intake at 120% of the healthy population over a 2 year period¹¹. In light of these

findings, the CF Foundation recommends children 1 to 12 years of age with growth deficits receive intensive treatment with behavioral intervention in conjunction with nutrition counseling to promote weight gain⁴.

In practice, implementing this recommendation across CF centers is challenging due to limited availability of trained behavioral psychologists or other members of the CF team with expertise in this type of intervention. Given limited resources, it is important to determine which patients might benefit the most from receiving intensive behavioral intervention to improve nutritional status. No study to date has examined factors that predict outcome with behavior intervention plus nutrition education to promote weight gain in CF. Baseline characteristics of the child's nutritional status including calorie intake, weight, and fat absorption all are theoretically important variables to examine with regard to their impact on treatment outcome. However, beyond these nutritional measures, are there characteristics of the child or parent that influence outcome? Behavior problems and maternal depression are two characteristics that should be evaluated as they have a strong evidence base in the behavior change literature. Specifically, more severe behavior problems¹²⁻¹⁴ have been associated with worse outcomes in the treatment of antisocial behavior¹², externalizing behaviors (e.g., anxiety)¹³, and general behavior problems¹⁴. Greater maternal depression^{12,13,15,16} has been linked to negative child treatment outcomes in these disorders, as well as early onset conduct problems¹⁶.

The objectives of this study were to examine whether baseline nutritional status, mealtime behavior problems, or maternal depressive symptoms predicted outcomes including caloric intake and weight following participation in a randomized, clinical trial to improve nutritional status in children with CF. We hypothesized that baseline fat absorption and caloric intake and weight (respectively) would contribute unique variance to baseline to post-treatment change in calories and weight. Further, controlling for the effects of treatment condition, we hypothesized that fewer mealtime behavior problems and lower maternal depressive symptoms would predict better baseline to post-treatment improvement in calorie and weight outcomes.

Materials and Methods

Participants

Subjects were recruited from five CF Centers located in the US. The study was approved by the institutional review committee at each medical center, consent and assent was obtained. Inclusion criteria were ages 4 to 12 years, diagnosis of CF by sweat test, pancreatic insufficient, and $\leq 40^{\text{th}}$ percentile weight for age and sex or weight for height at the time of chart review. Exclusion criteria included insulin dependent diabetes; significant developmental delays or impairments such as autism, cerebral palsy, or mental retardation; positive sputum culture for *b. cepacia*; or receiving supplemental enteral or parenteral nutrition.

Procedures

A randomized, multi-center study was conducted comparing behavioral plus nutrition education intervention (Be-In-CHARGE!; www.oup.com/us/pediatricpsych - go to online manuals page) to intensive nutrition education alone. Participants completed a baseline evaluation and follow-up assessments scheduled at post-treatment (9 weeks), and 3, 6, 12, 18, and 24 months after the conclusion of treatment. This article reports results in the context of the baseline and post-treatment evaluations. The details of each intervention protocol and study results related to health outcomes have been previously described¹¹. In brief, we found that while behavioral plus nutrition education resulted in significantly greater improvement in calories and weight gain compared to the intensive nutrition education alone, both groups made significant improvement over baseline. Because both interventions were equal in terms of the amount of time and contact in treatment and both resulted in improvement on caloric intake

and weight gain compared to baseline, the two groups were combined for all analyses. A home visit was conducted at the baseline and post-treatment evaluations and included collection of interview and questionnaire data.

Measures

Demographic information was obtained by parent self-report. Weighed food diaries were obtained on 14 consecutive days at baseline and post-treatment, reviewed by a registered dietician for accuracy and completeness, and analyzed for calories using Nutritionist IV/V, a standard computerized nutrition program (Salem, OR). Caloric intake was represented as total calories per day and change in calories is reported baseline to post-treatment. Children were weighed in under clothing and a paper hospital gown without shoes in triplicate at baseline and post-treatment following the guidelines established by Cameron¹⁷ by a trained measurer at each site. The weights at each time point were averaged and weight change is reported baseline to post-treatment. Parent and child mealtime behaviors were assessed using the Behavioral Pediatric Feeding Assessment Scale¹⁸, a reliable and well-validated parent report instrument^{18,19} that yields total problem (BPFAS Problem Score; range 0-35) and frequency (BPFAS Frequency Score; range 35 - 175) scores. Maternal depressive symptoms were assessed with the widely used Center for Epidemiological Studies – Depression Scale (CES-D)²⁰. Total scores of 16 or higher on this measure have been found to be predictive of major depressive disorder. Three-day fecal fat studies were performed baseline and post-treatment to assess fat absorption using the van deKamer method²¹. The coefficient of fat absorption (CFA) was calculated using the formula: $CFA = (\text{dietary fat in grams} - \text{stool fat in grams}) / \text{dietary fat in grams}$.

Statistical Analysis—The data were analyzed using the statistical packages SPSS (version 15.0; SPSS, Inc. Chicago Illinois). Means and standard deviations were calculated for demographic variables. Tests of baseline to post-treatment differences on nutritional status, health status, mealtime behavior problems and maternal depressive symptoms were conducted using paired sample t-tests. We used the primary outcome measures of change in mean calories per day and change in weight from baseline to post-treatment to assess predictors of outcome for the sample. We conducted hierarchical multiple regression analyses for each of the two dependent variables. In order to control for any effects from baseline caloric intake or weight (respectively) and fat absorption these variables were entered on the first step. Next, treatment group status (behavior plus nutrition education and nutrition education) was entered on the second step. Subsequently, BPFAS Problem and Frequency Scales and CESD scores were entered using a step-wise procedure.

Results

Study Population

A total of 79 children with CF and their families were randomized to treatment across 4 sites, 39 to behavior plus nutrition education and 40 to nutrition education only. Six families in each group dropped out prior to receiving active treatment. Thus a total of 67 subjects (35 boys and 32 girls) were included in these analyses. Children ranged in age from 4 to 12 years with a mean age of 7.64 years. Baseline and post-treatment nutritional status, health status, mealtime behavior problems, and maternal depressive symptoms for the sample are shown in Table 1.

Baseline Predictors of Change in Calorie Intake

Table 2 shows the final regression model for baseline predictors of change in calories from baseline to post-treatment ($F(5,59) = 6.58, p < .0001$). Neither baseline mean calories per day or fat absorption contributed significantly to the prediction of *change* in calorie intake with treatment. Group assignment accounted for 17% of the variance in outcome ($R^2 \text{ change} = .17$)

with children in the behavior plus nutrition education condition showing greater change in baseline to post-treatment calories. However even after accounting for the effects of treatment condition, the BPFAS Frequency Score accounted for unique variance in the final model (R^2 change = .11) as did the CES-D scores (R^2 change = .06). A lower frequency of baseline parent-child mealtime behavior problems and a higher level of baseline maternal depressive symptoms predicted greater improvement in baseline to post treatment calorie intake. The BPFAS Problem Score did not contribute unique variance in this model.

Baseline Predictors of Weight Gain

Table 3 shows the final regression model for baseline predictors of change in weight over the course of treatment ($F(4,60) = 5.50$ $p = .001$). Baseline weight (10%) and fat absorption (2%) each contributed significant variance to the prediction of *change* in weight from baseline to post treatment, with higher weight and better absorption predicting a greater weight increase. Treatment condition also contributed significant variance to the model, with children in the behavior plus nutrition education condition gaining more weight over treatment (R^2 change = .09). However, beyond the effects of the baseline variables and group assignment, the BPFAS Frequency Scale accounted for a modest, but significant component of variance (R^2 change = .06). Even after accounting for the effects of treatment condition, a lower BPFAS Frequency Score of baseline parent-child mealtime behavior problems predicted better weight gain. The CES-D Score and the BPFAS Problem Score did not enter into the regression model.

Discussion

To our knowledge, this is the first study to examine predictors of outcome in caloric intake and weight following participation in a randomized, clinical trial using behavioral intervention and nutrition education to improve nutritional status in children with CF. In this sample of 67 children with CF all $\leq 40^{\text{th}}$ percentile weight for age and sex or weight for height, these data demonstrated that less frequent baseline mealtime behavior problems lead to better caloric intake and weight gain over the course of a 9 week clinical trial. As previously reported patients receiving behavioral plus nutrition education, as compared to those receiving nutrition education alone, showed a significantly greater calorie increase and weight gain from baseline to post treatment¹¹. However, after controlling for the effects of type of intervention, frequency of mealtime behavior problems contributed to 11% of the variance in change in calories and 6% of the variance in change in weight from baseline to post-treatment.

These data have implications for clinical management of CF. Children who weighed more and had fewer mealtime behavior problems improved more from the intervention, highlighting the importance of early referral for behavioral intervention when nutritional status becomes a concern. The longer insufficient weight gain is a problem, the greater the likelihood that mealtime behavior problems will develop and intensify, thereby diminishing the potential success of future intervention.

The behavioral intervention and nutrition education treatments were clearly less effective for children with a greater frequency of mealtime behavior problems; however, although less effective they were not ineffective. These data provide initial clues about why some children do less well in treatment. For children with CF who have serious mealtime behavior problems, a more intensive or longer duration behavioral approach may be necessary than the 7-session, 9 week intervention used in this study. This is an important question for future research.

Contrary to a priori hypotheses, baseline nutritional measures of caloric intake and fat absorption did not contribute to the prediction of change in calories. However, baseline weight and to a lesser extent fat absorption did contribute variance to the prediction of change in weight; with higher baseline weight predicting better weight gain. Over the course of the

intervention, calorie goals were targeted to increase by 1,000 cal/day over baseline. Given that baseline calories did not influence the amount that calories were raised during the intervention, it makes sense that baseline intake would not predict caloric change. However, the finding that children who weighed more, did better also highlights the importance of early intervention.

Beyond nutritional status and type of intervention, we found that parental rating of the frequency of problematic behaviors during meals, rather than the absolute number of behaviors parents identified as problems, was a key predictor of outcome. That is how often problematic behaviors occurred was a better indicator of outcome than simply how many different types of mealtime behavior problems a parent identified. This finding has important implications for how we screen for mealtime behaviors in the clinic setting. Asking parents to report whether certain mealtime behaviors are problems from their perspective, is likely insufficient for identifying children with CF who are struggling behaviorally at meals. Our clinical screening tools, whether they are questionnaire- or interview-based, need to incorporate an empirical assessment of how often mealtime behavior problems are occurring.

We expected that higher levels of depression would predict worse outcomes both in terms of change in calories and weight over treatment, however, the opposite was the case. Level of depressive symptoms did not contribute unique variance to change in weight. Further, with regard to calorie intake, higher baseline depressive symptoms were related to greater change in caloric intake over treatment. While the sample mean was well below the clinical cutoff for depressive symptoms, over 20% of the sample met or exceeded the cutoff of 16. Symptoms of depression are common in parents of children with CF^{22,23}, which has prompted a national prevalence study (tides-cf.org). Our results suggest that children of mothers who report higher levels of depressive symptoms are likely to benefit from participation in behavioral or intensive nutrition intervention to improve nutritional status in CF and that maternal depressive symptoms should not be considered a contraindication to referring a family for this type of treatment. In the current study the finding that children of mothers with higher depression did better may reflect the benefits of group treatment. That is, although maternal depressive symptoms did not change from baseline to post-treatment it may be that the support received in the intervention for making changes in their child's diet was helpful to taking action.

Given the importance of weight and nutritional status to health outcome in CF¹⁻³, the CF Foundation recommends children 1 to 12 years with growth deficits receive intensive treatment with behavioral intervention in conjunction with nutrition counseling to promote weight gain⁴. Our study demonstrated that less frequent baseline mealtime behavior problems led to better caloric intake and weight gain over the course of a 9 week clinical trial of behavioral intervention and nutrition education. The key implication from these findings is that early referral to behavioral intervention as soon as growth deficits become a concern will likely yield the best nutritional outcomes.

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Table 1

Mean (SD) Baseline and Post-Treatment Sample Characteristics for Nutritional Status, Health Status, Mealtime Behavior Problems and Maternal Depressive Symptoms

	Baseline	Post-Treatment	t-value
Calories per Day	1810	2488	-12.49 ^a
(N=67)	(416)	(575)	
Weight (kg)	22.21	23.40	-8.25 ^a
(N=67)	(6.93)	(7.40)	
BMIZ	-.63	-.35	-4.86 ^a
(N=67)	(.94)	(.95)	
Fat Absorption	82%	88%	-3.86 ^a
(N=63)	(14)	(07)	
BPFAS Frequency	69.57	68.36	.76
(N=67)	(15.21)	(12.80)	
BPFAS Problem	7.24	6.59	.76
(N=66)	(7.36)	(5.29)	
CES-D	11.49	10.25	1.12
(n=67)	(8.35)	(7.36)	

^a
p<.001

Table 2

Final Hierarchical Multiple Regression Model for Baseline Predictors of Change in Calories from Baseline to Post-Treatment

	Standardized Coefficients			
	B	T	R ²	R ² change
Baseline Calories	-.18	-1.67	.01	.01
Fat Absorption	.08	.76	.02	.01
Group	.48	4.45 ^c	.19	.17
BPFAS Frequency Score	-.37	-3.42 ^b	.30	.11
CESD	.24	2.30 ^a	.36	.06

^a
p<.05

^b
p<.01

^c
p<.001

Table 3

Final Hierarchical Multiple Regression Model for Baseline Predictors of Change in Weight from Baseline to Post-Treatment

	Standardized Coefficients			
	B	T	R ²	R ² change
Baseline Weight	.23	2.01 ^a	.10	.11
Fat Absorption	.24	2.10 ^a	.12	.02
Group	.34	3.02 ^b	.21	.09
BPFAS Frequency Score	-.25	-2.14 ^a	.27	.06

^a
p<.05

^b
p< .01