An examination of nutritional outcomes from an intensive outpatient pediatric feeding program for children with feeding difficulties

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Abstract

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BACKGROUND: Children with feeding disorders consume an insufficient volume or variety of food. This can compromise growth and development and the child may require enteral nutrition. Pediatric feeding disorders have complicated etiologies and require assessment from an interdisciplinary team to address all aspects of the child's condition. **OBJECTIVES**: The purpose of this study was to evaluate the nutritional and behavioral outcomes of an intensive outpatient program for children with feeding disorders. **METHODS**: Of 14 children with severe feeding disorders in the program, 12 participated for two weeks of meal sessions and were included in the study. Therapists collected data for refusal behavior, amount, and variety of intake at baseline and post-treatment. Nutritional adequacy was based on two-thirds the Dietary Reference Intakes for energy, protein, carbohydrates, sodium, potassium, vitamin A, vitamin C, calcium, iron, vitamin E, dietary fiber, and fat. **RESULTS**: For all 12 participants, amount and variety significantly increased while food refusal significantly decreased. Variety of vegetables, fruits, dairy, protein, and grains also increased. Nutritional adequacy of protein and calcium increased for all 12 participants, while the other nutrients increased for seven to 11 participants. Fat as a percentage of energy was adequate for three participants at baseline and four post-treatment. **DISCUSSION**: Children in the program demonstrate feeding improvement, which is

a vital step toward a balanced diet. Participants decrease food refusal and increase intake. It is possible for children with pediatric feeding difficulties to meet or exceed two-thirds of recommended intake for many nutrients during in-clinic sessions. Improving percentage of fat in the diet is not a practicable short-term goal. **IMPLICATIONS**: Clear expectation about the effects of treatment will improve parent satisfaction during the pediatric feeding program for children with feeding difficulties. This improved behavior and intake may reduce the risk of health and growth problems associated with inadequate nutrition.

INTRODUCTION

Children with feeding disorders consume an insufficient volume or variety of food to grow or maintain nutritional well-being[1]. Feeding problems affect around 25% of all children[2, 3], and the prevalence of failure to thrive has been estimated to be close to 10% before age 24 months[4]. The prevalence of feeding problems is up to 61% in those with developmental disability[3]. An analysis of children with feeding problems enrolled in an interdisciplinary feeding program showed that 64% of participants had developmental disabilities including Down syndrome, cerebral palsy, and autism spectrum disorder (ASD)[1], suggesting a relationship between developmental disabilities and feeding problems. Children with (ASD) have more feeding problems than children without ASD[5], such as selectivity by type and texture[1], and food refusal and selectivity are more common in ASD than in those with other disabilities[6, 7]. In children with ASD, the odds of having a feeding problem are estimated to be five times higher than in those without[8]. A study of children with ASD and eating habits showed that 72% of this population exhibit food selectivity, while 57% exhibit food refusal[9].

Overall, children with feeding disorders present with a wide range of difficulties that include total food refusal, severe dietary restriction, failure to advance to age-appropriate textures, liquid or tube dependence, and oral motor delays or dysphagia[1]. Those with food selectivity may eat a narrow variety of foods[5, 9, 10], have specific texture requirements[5, 11], and have specific utensil requirements[5, 12]. Subtypes of food refusal are selectivity by texture, selectivity by type, combination selectivity by texture and type, and total food refusal, and each of these subtypes have distinct characteristics[13]. Children who refuse food often exhibit behavior such as verbal rejection, leaving table, pocketing with refusal to swallow, spitting food, choking, and gagging[14] or extreme behavior including tantrums, crying, screaming, aggression, self-injury, and throwing items[15].

In a study of patients referred to an interdisciplinary feeding team for poor growth and feeding, 85% of cases were classified as relating to multiple rather than single etiologies, most commonly combinations of structural (eg, cleft palate, tracheotomy), neurological (eg, cerebral palsy, developmental delay), and behavioral etiologies[16]. Other combination etiologies for feeding problems included cardiorespiratory issues and metabolic dysfunction[16]. Studies of children enrolled in feeding programs suggest the most common medical conditions associated with feeding problems are dependence on enteral nutrition for feeding[17, 18], gastroesophageal reflux (GERD)[1, 17, 18], esophagitis and duodenitis[18], and GI issues including diarrhea, constipation, and food intolerance[1]. Feeding difficulties are also associated with premature birth[19] and need for breathing support[17, 19]. Behavioral bases of feeding problems include psychosocial interaction such as conditioned aversions and negative or positive reinforcement that shapes and maintains food refusal behavior over time[16]. In behavioral literature, behaviors are increased due to presentation of something preferred (positive reinforcement) or removal of something aversive (negative reinforcement) in response to a behavior[20]. For example, presentation of food is aversive or undesirable to children with feeding difficulties, and they may engage in food refusal behavior in order to avoid it. If the child is then allowed to escape eating or escape a nonpreferred food type, this negative reinforcement is likely to result in increased refusal behavior over time. Thus, it is important to consider how these behavioral interactions shape and maintain both appropriate and inappropriate behavior during meals. In summary, children with feeding disorders are a heterogeneous population that typically have dual etiologies of medical and behavioral factors and require assessment from an interdisciplinary team of child and behavioral psychologists, medical personnel, registered dietitians, occupational therapists and speech and language therapists that can address all aspects of these multifactorial problems[21].

Mealtime refusal behavior and selectivity can cause stress during meals for caregivers[22], parents, and teachers[23]. As one example of the vicious cycle of problem feeding behavior with both a behavioral and medical etiology, consider a child who associates pain from GERD with the oral consumption of food. What may then result from this complicated interaction is the emergence of food refusal behavior by the child to escape or avoid eating to escape the pain[24, 25]. After resolution of the GERD, food refusal behavior may persist due to this learned behavior[18]. When oral intake is insufficient for adequate development, a child may require nutrition support, such as enteral nutrition[21]. For example, a child who is temporarily restricted from oral consumption during treatment that requires nutrition via gastrostomy tube may be likely to avoid eating after treatment is complete[25, 26]. Although children presenting with food refusal and selectivity may have the skills to eat appropriate foods despite this behavior[1], many children who refuse to eat by mouth miss opportunities to develop skills such as coordinating the tongue, chewing, sucking, swallowing, and breathing[24]. The stress and problems at mealtime continue even after the original medical problem has been treated, due to lack of practice with eating skills and reinforcement of inappropriate behavior by the caregiver who removes the food to end stressful behavior and feelings in his or her child[18]. As the child succeeds in avoiding nonpreferred food types/textures or obtaining a preferred food instead, the refusal behavior is strengthened to a point that requires behavioral intervention[18].

Severe food refusal compromises growth and causes malnourishment and dehydration[15]. Undernutrition is associated with impaired growth and mental development[27]. Lack of intake of specific nutrients can be a problem, such as iron deficiency[28], which is associated with altered sleep organization[29] and, even after treatment, is also associated with long term cognitive, motor, and emotional problems[30].

Studies of nutritional adequacy and growth and weight in children with feeding problems, including food refusal and selectivity[31], have been conflicting. This may be due in part to the heterogeneity of the subtypes in the population. However, in typically-developing children, “picky eating,” which can be measured by the percentage of refused foods to offered foods or decreased repertoire of foods in the diet across food groups[32], is associated with fewer foods eaten and less variety[33]. This can result in an inadequate intake of protein[34], fruits[34], and vegetables[32-34]. In contrast, a study of toddler diet adequacy based on measures of diversity and variety found that picky eating is associated with lower variety but not decreased nutrient intake[35]. In fact, some studies in children find no correlation between picky eating and growth[35, 36] or height and weight[37], whereas others demonstrate that picky eating in typically-developing children is associated with underweight[38-40].

In children with ASD, some studies show no risk for nutritional deficiency[41, 42], while others suggest risk for inadequate vitamin intake[10, 32, 43, 44] or lower intake of specific vitamins[45, 46], overweight[47], or obesity[48, 49]. A meta-analysis of prospective studies on nutrient intake and children with ASD suggested that although ASD is not associated with difference in height, weight, or BMI compared to controls, it is associated with deficits in calcium and protein[8]. Down syndrome as well as ASD has been shown to be associated with overweight and obesity[49]. Children with developmental disabilities and overweight are at higher risk for high cholesterol, blood pressure, and diabetes[49]. However, lower BMI has been shown in children with ASD[50] and a population of children with ASD and severe feeding difficulties[51]. ASD is also associated with lower bone density[52], cortical thickness[53], and increased risk for fractures[54]. These deficiencies put children at risk for long-term health complications[30, 52, 55].

Children with pediatric feeding disorders require an interdisciplinary assessment with clinicians from medical, behavioral psychology, nutrition, occupational therapy, and speech/language in order to identify and address multiple interacting etiologies, as treating only one component may worsen the feeding problem[24]. Including child and behavioral psychologists with expertise in applied behavior analysis is often critical to identify any associated mental health and behavioral factors associated with mealtime difficulties[24]. Behavioral interventions are shown to be the most empirically supported treatments for children with pediatric feeding disorders[56-60]. In order to identify what aversive stimuli results in food refusal, behavioral evaluation includes analysis of both antecedent and consequent conditions for appropriate and inappropriate mealtime behavior[61]. After identifying antecedent stimuli (eg textures, food types), and associated consequent events, the team can develop interventions that result in appropriate intake[61]. Effective behavioral interventions for these children include differential attention with focus on positive reinforcement and possible inclusion of extinction for undesirable behavior[56]. Behaviorally, escape extinction is defined as the removal of the reinforcer for a behavior, which results in an inappropriate behavior no longer resulting in access to the desired reinforcer. Over time the inappropriate behavior decreases[56]. An example of escape extinction in feeding therapy is to maintain the spoon during offer of a bite rather than pulling it away in response to food refusal behavior. Positive reinforcement, such as verbal praise or access to preferred toys, foods, or activities, rewards the child for bites accepted or swallowed[56]. Escape extinction alone or paired with positive reinforcement has been shown to be the most effective[62]. Other antecedent-based treatments include behavior momentum, or offering preferred foods sequentially/simultaneously with nonpreferred foods, texture manipulation, bite or utensil fading, or changing the texture of food to increase acceptance[23].

The Pediatric Feeding Program at Seattle Children's Autism Center in Seattle, WA, is the only feeding-related intensive outpatient program (IOP) of its kind in the Northwest. The interdisciplinary program provides assessment and individual behavioral treatment for children up to age 13 who have feeding disorders with and without ASD diagnoses. This interdisciplinary team includes registered nurse practitioners, pediatric and behavioral psychologists, occupational therapists, registered dietitians, and board certified behavior analysts who assess the unique medical, nutritional, sensory, oral-motor, mental health and behavioral factors that might contribute to presentation and maintenance of a child's feeding difficulties. The team develops an assessment and treatment plan individualized for each child and family. The team, including the family, continues to collaborate together during the course of treatment to evaluate meal-by-meal data to determine next steps. After identification of appropriate treatment that results in appropriate eating and reduction in mealtime disruptions, the team trains the parents so the family can establish feeding at home and other settings. The team compiles data on a bite-by-bite basis on the child, therapist, and parent behavior.

As the Pediatric Feeding Program at Seattle Children's Autism Center is one of only few interdisciplinary pediatric feeding programs that exist, studies of nutritional outcomes of these programs are limited. A similar intensive interdisciplinary feeding program used individualized behavior treatment for children with feeding disorders and showed that the program increased food acceptance and grams of food consumed, decreased refusal behavior, and generated positive caregiver satisfaction[57]. Other studies of similar behavioral treatment programs for children with pediatric feeding disorders reported improvement in the variables of acceptance and refusal behaviors[58, 63-65], oral intake amount[65, 66], energy intake[58, 59, 64, 67], length of meals[65], or caregiver stress[64], and also reported growth outcomes[58, 59, 64]. Aside from energy intake, these studies did not provide information about nutrient intake or nutritional adequacy.

The purpose of this study is to evaluate the nutritional and behavioral outcomes of this intensive outpatient program (IOP) for children with feeding disorders. The first aim is determine if there are differences between daily food consumption and mealtime behavior at baseline and post-treatment across three dependent measures. We hypothesize that (a) the number of food types will increase after treatment as compared to baseline, (b) the overall volume consumed will increase after treatment as compared to baseline, and (c) the percentage of bites associated with food refusal will decrease after treatment as compared to baseline. The second aim is to compare the nutrient adequacy of the foods consumed in clinic at baseline and after treatment. We hypothesize that nutritional adequacy of energy, protein, carbohydrate, fat, sodium, potassium, vitamin A, vitamin C, vitamin E, calcium, iron, and dietary fiber from in-clinic meals will improve for children with feeding problems after participation in the IOP compared to baseline.

METHODS

Participants

The original sample included 14 children admitted to the IOP for the period of July, 2012 to July, 2014. Participants who did not complete the two-week program were excluded from this analysis. Of the 14 participants, two participants were excluded due to shortened admission and singular treatment focus (eg, learning to drink milk from a cup).

The sample included nine males and three females aged one year 10 months to 13 years one month (mean age 6.84 years). The majority of participants were non-Hispanic white (n = 8), two children were Asian, and two were Hispanic or Latino. All children were diagnosed with pediatric feeding disorder. The other most common medical and mental health diagnoses included anxiety disorders (n = 9), autism spectrum disorder (n = 7), disruptive behavior disorder (n = 5), attention deficit hyperactivity disorder (n = 2), food allergy (n = 5), gastrointestinal difficulties such as GERD, eosinophilic esophagitis, esophageal atresia, constipation, Nissen fundoplication, and pyloric stenosis (n = 11), and genetic disorders (n = 1). Of the 12 participants, five received treatment for liquid dependence, five for total food refusal (eg, not eating anything by mouth), four for food refusal by type of food only (ie, limited variety), and three for combination of food refusal by type and difficulties transitioning to advanced textures. A total of six participants were dependent upon gastrostomy tube for supplemental nutrition. The total food refusal group contained the highest number of gastrostomy tube dependent participants (n = 4). Figure 1 summarizes the feeding restriction subtypes and gastrostomy tube dependence by feeding restriction subtype.

The most common referring problems included food refusal or selectivity by type and texture, swallowing problems, disruptive or self-injurious behavior, and aggression at mealtimes. All participants had prior speech, occupational, and psychological therapy for one to seven years as well as consultation with a registered dietitian.

Participants in the IOP attended clinic for two weeks, five days a week for three to four hours of interdisciplinary behavioral treatment including behavioral analytic assessment and treatment, and one to two hours of occupational therapy each week, depending on the needs of the child. Participants and parents met with a nurse practitioner daily and a pediatric registered dietitian weekly. The protocols developed during therapy were individualized for each patient/family team and informed consent obtained prior to any assessment or treatment. Behavioral treatment involved in-clinic meal sessions, and occupational included two-hour weekly sensory-based recommendations, adaptive mealtime supports and oral-motor exercises with an occupational therapist. Each day included three meals broken into several mini-sessions per child for 10 days unless otherwise specified in the individual treatment plan.

Dependent Variables

Food Refusal

Food refusal was defined as the child engaging in any behavior to avoid accepting a bite offer including pushing the utensil away, turning the head more than 45 degrees from midline, covering the mouth, expelling food, tucking the head, turning the head or body, or moving the utensil at least 45 degrees from midline and leaving the table. Mean food refusal was calculated based on the percent of bites associated with food refusal per session during baseline and the last three meal sessions.

Amount Consumed

Oral intake was defined as the amount of food, in grams, consumed at each meal session. Trained therapists weighed foods before and after meal sessions and recorded the number of grams consumed orally of each food, liquid, or food combination on daily food logs.

Food Logs

Therapists used food logs to record the amount, type, and recipe of food or liquid offered and consumed during meal sessions. The foods recorded included amount of calorie boosters when utilized (eg, butter added to green beans).

Variety

Variety scores were defined as the number of different food types accepted and logged at baseline and the number of new food types accepted and swallowed during treatment. New snack foods (eg potato chips, candy) were not included. Therapists totaled the number of foods accepted by each participant throughout admission and categorized them into five food groups: vegetable, fruit, protein, dairy, and grain. Baseline variety was defined as the number of foods accepted at all of the baseline sessions, and post-treatment variety was defined as the number of new foods accepted throughout the course of admission, excluding foods accepted at baseline. Combination foods were categorized as multiple foods (eg, cheese pizza as one dairy and one grain). Potatoes and avocados were categorized as vegetables. The list of foods excluded liquids (milk, water, liquid juice) but included smoothies and ice cream. Dairy alternatives (eg, soy cheese) were categorized as dairy foods. Foods that fit in to none of the above categories (eg, olive oil, candy) were excluded in the count.

Nutritional Adequacy

A nutritionist used Nutritionist Pro™ software (version 5.4.0, Axxya Systems, 2014) to analyze energy, protein, carbohydrates, fat, sodium, potassium, vitamin A, vitamin C, calcium, iron, vitamin E, and dietary fiber in the foods consumed during the first and last thee meal sessions for each child. For combination foods such as mixed purees or plates with more than one food where no recipe was otherwise provided, a nutritionist created a recipe in the software made up of equal amounts by weight of each food component. The number of grams consumed of that combination was then included in the nutrient analysis. When not otherwise specified, milk and yogurt were categorized as reduced fat (two percent milk fat). The feeding team provided clarification about items in the food logs as needed.

We calculated the nutritional adequacy scores for each nutrient by comparing intake against two-thirds (66.7%) of each participant's daily need as determined by the Institute of Medicine (IOM) Recommended Dietary Allowances and Adequate Intake (RDA/AI)[68, 69] and expressing the results as percentages at baseline and post-treatment. We calculated the adequacy scores for energy by comparing intake against two-thirds of the energy needs estimated by the registered dietitian in the medical chart and expressing the results as percentages at baseline and post-treatment. When the chart indicated a range for estimated energy needs, the adequacy score was based on the lower end of the range. Nutritional adequacy for fat was determined based on whether amount of fat, as a percentage of total energy, was within or outside the Acceptable Macronutrient Distribution Range (AMDR) as defined in the IOM Dietary Reference Intakes (DRIs)[68].

Procedures

Treatment was individually designed for each patient and family and the foods used in clinic were those that the caregivers identified as targets at baseline and brought from home. Parents of children on pureed diets were trained to puree different food types in clinic prior to meals. The meal session room was set up with a chair or high-chair, a table, and familiar dishes, utensils, toys, and activities. The parents or caregivers were always present during sessions as active participants, as parent involvement is an essential component of treatment.

Caregivers provided informed consent as part of the program admission. Data were collected at each session and across each bite presentation via event-recording measures either directly in person or later via video recordings. Data included bite-by-bite analysis of food refusal, bite size, bite type, gagging and vomiting, negative vocalizations, duration to complete a bite, bite approximations, tastes, measurement of post meal grams of familiar and novel foods consumed, and food choice. Only trained therapists collected the dependent variables throughout the course of each participant’s admission. Therapists followed protocols to protect patient confidentiality and pursued IRB approval to collect on outcomes.

Case records from the Pediatric Feeding Program's Intensive Outpatient data were reviewed from the period of July 2012 to July, 2014.

We measured the food intake and food refusal during in-clinic meals at baseline phase and post-treatment phase (the last three meal sessions). We calculated the mean number of occurrences of directly observable behaviors at baseline and post-treatment. Length of these phases varied depending on clinical necessity to establish stable patterns of behavior.

Reliability and Data Collection

Observation System

All sessions were videotaped and scored by two trained feeding therapists. Data were collected during sessions or post sessions by viewing the videotape on a bite-by-bite basis using an event recording system.

Interrater and Interobserver Reliability

Trained data collectors independently scored 30% of the sessions across all phases for all children included within this study. Interobserver occurrence agreement was calculated on a bite-by-bite basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100 percent. The total agreement averaged above 80% for food refusal, 100% grams, and 100% for variety.

Interrater reliability of the chart reviews for 20% of the sample (randomly selected) was collected. The case records of these children were systematically reviewed by two data collectors. Reliability of data collection was then evaluated across all relevant variables reported in the study, excluding dietary analysis, by dividing number of agreements by the number of agreements plus disagreements and multiplying by 100 percent. Interrater reliability was found to be above 90 percent.

Statistical Analysis

We performed Statistical analyses using Microsoft Excel (version 14.0.7128.5000, Microsoft Corporation) spreadsheet software to generate mean ± standard deviation (SD), compute t-tests, and generate graphs. We used t-tests to compare baseline and post-treatment data for mean food refusal, grams consumed, and variety scores for all participants, and generated graphs to compare the same for participants with food refusal by type only. We generated adjacent visual graphs to represent change in adequacy scores for nutrients at baseline and treatment phases for each participant. In order to analyze a more heterogeneous group of selective eaters without effects of liquid dependence or texture manipulation, we also calculated mean scores for the group of participants with selectivity by type only.

RESULTS

Amount Consumed

The number of healthy food grams consumed increased for all 12 participants. The change in mean number of grams consumed was significantly different ($t(11)= -2.46$, $p<0.01667$) and increased from 8.9 ± 13.45 at baseline to 130.4 ± 179.84 post-treatment. Figure 2 illustrates the mean number of grams consumed at baseline and post-treatment for all participants. Figure 3 illustrates the mean number of grams consumed for participants with food refusal by type only.

Food Refusal

Food refusal decreased for all 12 participants. The mean food refusal measure for all participants significantly decreased from 60.2% ± 24.32 at baseline to 6% ± 6.40 post-treatment ($t(11)=8.13$, $p<0.01667$). Figure 4 illustrates the food refusal measure at baseline and post-treatment for each child. Figure 5 illustrates the mean food refusal rates at baseline and post-treatment for participants with food refusal by type only.

Variety

The total variety scores of healthy food options chosen by the parents increased for all 12 participants. The mean total variety scores at baseline and post treatment significantly increased. The mean variety scores, which exclude snack foods such as candy, also significantly increased for all food groups (Table 2).

Of the participants with food refusal for type only (n = 4), the mean adequacy scores increased for every nutrient except vitamin E, which decreased. Figure 8 illustrates the mean adequacy scores at baseline and post-treatment for participants with food refusal by type only.

Nutritional Adequacy

Figure 8 summarizes adequacy scores visually for all 12 participants by nutrient. Both calcium and protein increased for all 12 participants, while the rest of the nutrients increased for seven to 11 participants. Vitamin E increased for the smallest number of participants (n = 7) and remained the same for three participants.

For participants with selectivity by type (n = 4), the mean adequacy score increased for every nutrient except vitamin E (Figure 9). Vitamin C was the only nutrient with a nutritional adequacy score of 100% or higher at baseline, and was the highest post-treatment. Mean nutritional adequacy scores for protein, carbohydrate, sodium, vitamin A, and vitamin C were above 100% post-treatment for this group.

The total fat intake as a percentage of total energy was within the individually defined AMDR for three participants at baseline, and four post-treatment. Of the three participants within AMDR for fat at baseline, two were within rage post-treatment (Table 4).

DISCUSSION

Aim One: Food Refusal, Amount, and Variety

Analyses of the food refusal behavior and foods consumed during a two-week IOP for children with feeding disorders showed that participants significantly (a) increased variety, (b) increased intake, and (c) reduced food refusal behavior after interdisciplinary treatment. The percentage of food refusal behavior significantly decreased and the number of foods accepted and amount of food consumed significantly increased. Further, total variety significantly increased for vegetables, fruits, proteins, dairy foods, and grains. The children in the IOP demonstrated substantial improvement in feeding, which is vital in order to move toward the overarching goal of achieving a balanced diet. In addition, the parents were all trained in the mealtime procedures and implemented treatment with adequate integrity at the conclusion of treatment.

Results of this study are consistent with past examinations of behavioral programs in terms of reductions in inappropriate behavior[57, 58, 63-65], increases in amount consumed[57, 65, 66], and increases in variety of foods consumed[57]. A recent systematic review of small group studies of behavioral analytic interventions to improve volume, variety, and eating behaviors in children with autism suggested that these treatments increased volume but not variety[60]. The present study extended the current literature in documenting that interdisciplinary behavioral treatment results in improved diet in children with feeding disorders with and without autism. Laud et al (2009) demonstrated a long-term increase in variety of total foods, but not specific types of foods across targeted food groups. The current study extended the limited literature, not only illustrating that interdisciplinary behavioral interventions significantly increased total variety, but also significantly increased total variety of fruits, vegetables, protein, dairy, and grains, resulting in more balanced diets. These findings are based on the number of healthful foods accepted and exclude those such as chips and/or candy, suggesting that behavioral intervention increases variety and volume of healthy foods consumed.

At baseline the grain food group included the largest mean number of foods accepted. Post treatment, the food groups with the greatest number of foods accepted were fruits, followed by grains and vegetables. The popularity of fruit and vegetables post-treatment may be reflective of the caregivers' individual goals and focus on these foods for their children.

Aim Two: Nutritional Adequacy

The current study is the first to assess the change in consumption of nutrients in addition to refusal behavior and food intake after treatment in an IOP for children with feeding disorders. This heterogeneous group of participants had feeding problems that ranged from total food refusal and liquid dependence to food refusal by type and/or texture. Some participants refused all oral intake at baseline, so increased nutrient intake reflected the initiation of food acceptance during treatment. Participants with food refusal by type generally accepted foods at baseline, but treatment was associated with an increase in variety and hence increased nutrient adequacy as a wider variety of healthful, nutrient-dense foods were consumed. The data highlights the nutritional difference between those who refuse food in general and those who refuse food by specific types.

For participants with selectivity by type, vitamin C was the only nutrient with a mean adequacy score above 100% at baseline. However, the mean adequacy scores post-treatment for some nutrients surpassed 100%, with vitamin C well over 300%, and even 1300% for one participant. This not only indicates that it is possible for these children to meet two-thirds of the RDA/AI for many nutrients during the in-clinic session hours, but that it is possible to exceed these amounts. Therefore, considering the Tolerable Upper Limits (UL) as defined in the DRI[68] for these nutrients is still important for children treated for feeding disorders, especially when making recommendations about vitamin and mineral supplementation.

For example, one participant decreased intake of vitamins A, C, and E from baseline to post-treatment, while another decreased intake of vitamins A and C. Decrease in vitamin intake post-treatment is likely due to consumption of a multivitamin at baseline or consuming only selective foods at baseline. For these participants, the score for these vitamins was above 100% for nutritional adequacy at baseline, and many scored close to or above 100% post-treatment, even after the decrease. Rather than focusing only on increasing nutrients, it is important to consider RDA/AI or AMDR for each nutrient. This is especially true for nutrients such as sodium and fat, which are typically high in the American diet and excess intake is associated with chronic disease[70].

The number of participants whose intake was within the AMDR for fat as a percentage of total energy increased from three at baseline to four post-treatment. However, not all participants within the range at baseline remained so post-treatment. These results suggest that during this two-week IOP, improving percentage of fat in the diet is not a practicable short-term goal.

At baseline, all participants were below or very close to 100% adequacy for sodium. Post treatment, only one participant scored in excess of 100% adequacy for sodium. This data suggests that children with pediatric feeding disorders can achieve increased intake and variety without excessive amounts of foods high in added salt.

Limitations

The limitations of this study include the small number and heterogeneity of participants, which made it unfeasible to statistically compare the mean adequacy scores of individual nutrients for all participants. Because of the heterogeneity and individual nature of the participants and treatment, visual representation was the most appropriate way to compare change in nutritional adequacy of specific nutrients from baseline to post-treatment. In addition to providing information about the change in nutritional adequacy, this study suggests visually whether participants with selectivity were at risk for consuming inadequate or excessive amounts of individual nutrients at baseline.

Children with food refusal by type eat a limited variety of foods[5, 9], and thus larger proportions of a smaller number of foods. Accordingly, participants with food refusal by type may consume specific nutrients in excess of the recommended daily amount, while lacking in others. This potential variability could have caused an increase in mean adequacy scores for individual nutrients at baseline and consequently weaken the effect post treatment.

Past studies have shown that children with autism are at higher risk for inadequate intake of nutrients including vitamin D[10, 32], calcium[8, 10, 32], and protein[8]. The current study showed that with treatment, nutrients such as calcium and protein can increase in the diet while inappropriate food refusal can decrease with interdisciplinary behavioral treatment. This study did not include analysis of vitamin D because sunlight exposure is a source in addition to diet, and supplementation is recommended for children who have inadequate sun exposure[71]. Children who are selective eaters or refuse food are therefore not likely to increase consumption of vitamin D through diet after treatment in amounts that are relevant to this study. However, future studies that include comprehensive diet logs should include analyses of additional nutrients such as zinc and vitamin B12 that have been shown to be associated with inadequate intake in those with autism[10].

A more focused study of fat intake should include analysis of saturated fat, unsaturated fat, and individual fatty acids. Some saturated fatty acids are the components of total fat intake that have been shown to be associated with chronic disease[70] and separating these fats out will better clarify nutritional adequacy.

The foods offered during treatment in this IOP were based on the family goals and individual treatment plans and therefore different for each participant. The strength in this is that these foods represent those that the caregiver will offer the child in the home. Although the food is familiar and representative of meals offered in the home and the room is set up with familiar utensils and toys, the clinic setting is not entirely generalizable to a typical meal in the home.

The in-clinic meal sessions during the IOP do not represent an entire day of intake. The data represented change during in-clinic meals and did not account for foods eaten between sessions outside of clinic. Further, although the participants decreased food refusal and increased the amount of food eaten at meal sessions, this study does not address the long-term outcomes of food refusal and amount of intake. Further research would include food logs for all intake during clinic as well as outside the clinic, and then follow up with food logs at defined future time points.

Because the food logs represent data from in-clinic meal sessions and not total diet, the adequacy score measure is useful for comparing baseline and post-treatment data. The adequacy score is not necessarily a score of nutritional adequacy of a child’s diet.

The Nutritionist Pro™ software contains a comprehensive database of foods and nutritional information. However, if a food item in the database did not contain information about a specific nutrient, then that nutrient amount counted as zero for that food. Therefore, some nutrients may be underrepresented in the nutritional analysis if a participant consumed a large amount of one food containing a missing nutrient value. Vitamin E increased for the smallest number of participants, and remained at zero at baseline and post-treatment for three participants. This is likely reflective of absent information for that vitamin in the nutrient analysis software.

CONCLUSION

The profound increase in variety and amount of food consumed by some children, with the strong reduction in food refusal, shows how important the program is for families of children with severe feeding difficulties. In order to achieve nutritional adequacy with a healthy, varied diet, children who are severely selective or refuse all food must first begin to accept new foods. This study shows that children with feeding difficulties can increase intake of a variety of healthful foods without negatively affecting nutrient balance. Children with feeding difficulties this severe require the interdisciplinary team approach of this pediatric feeding program to provide a coordinated plan to address psychological, medical, nutritional, and oral-motor concerns in order to achieve this first step. Further, the inclusion of the registered dietitian is important to contribute guidance on tube weaning and food choices in order to provide adequate nutrients from foods appropriate for behavioral treatment. The role of the registered dietitian is also important for assessment of nutrient intake during treatment.

The results of this study provide information about the strong effect of interdisciplinary treatment in an intensive outpatient program for children with feeding disorders on refusal behavior, food quantity, and food variety, as well as information about intake of vitamins, minerals, and nutrients. This will clarify what caregivers might be able to expect from such a program. Clear expectation about the effects of treatment will contribute to parent satisfaction during an already stressful situation. In addition, it is hoped that this reduced refusal behavior and increased intake may reduce the risk of health and growth problems associated with inadequate nutrition.

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TABLES AND FIGURES

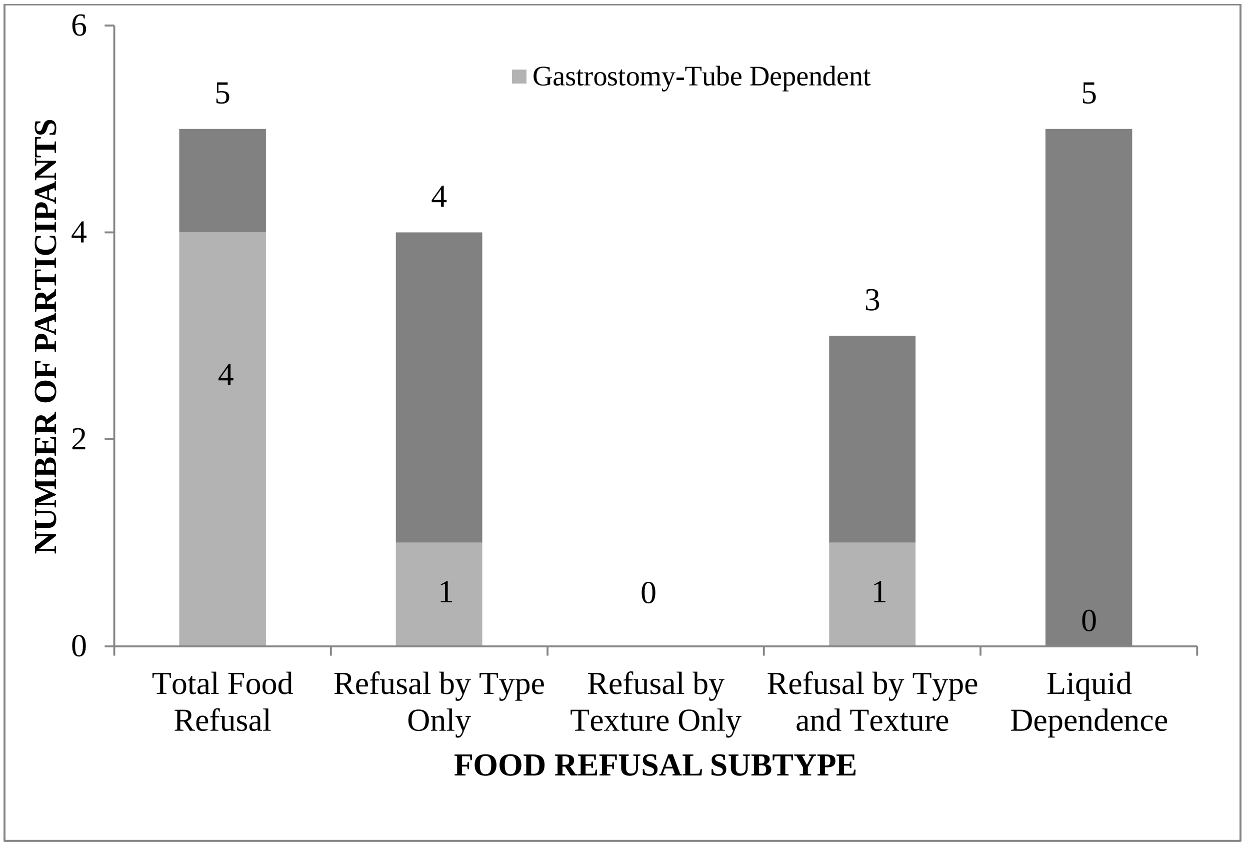


FIGURE 1: Number of participants enrolled in the Pediatric Feeding Program (total n = 12) by food refusal subtype and number of participants per food refusal subtype who were dependent on gastrostomy-tube on admission.

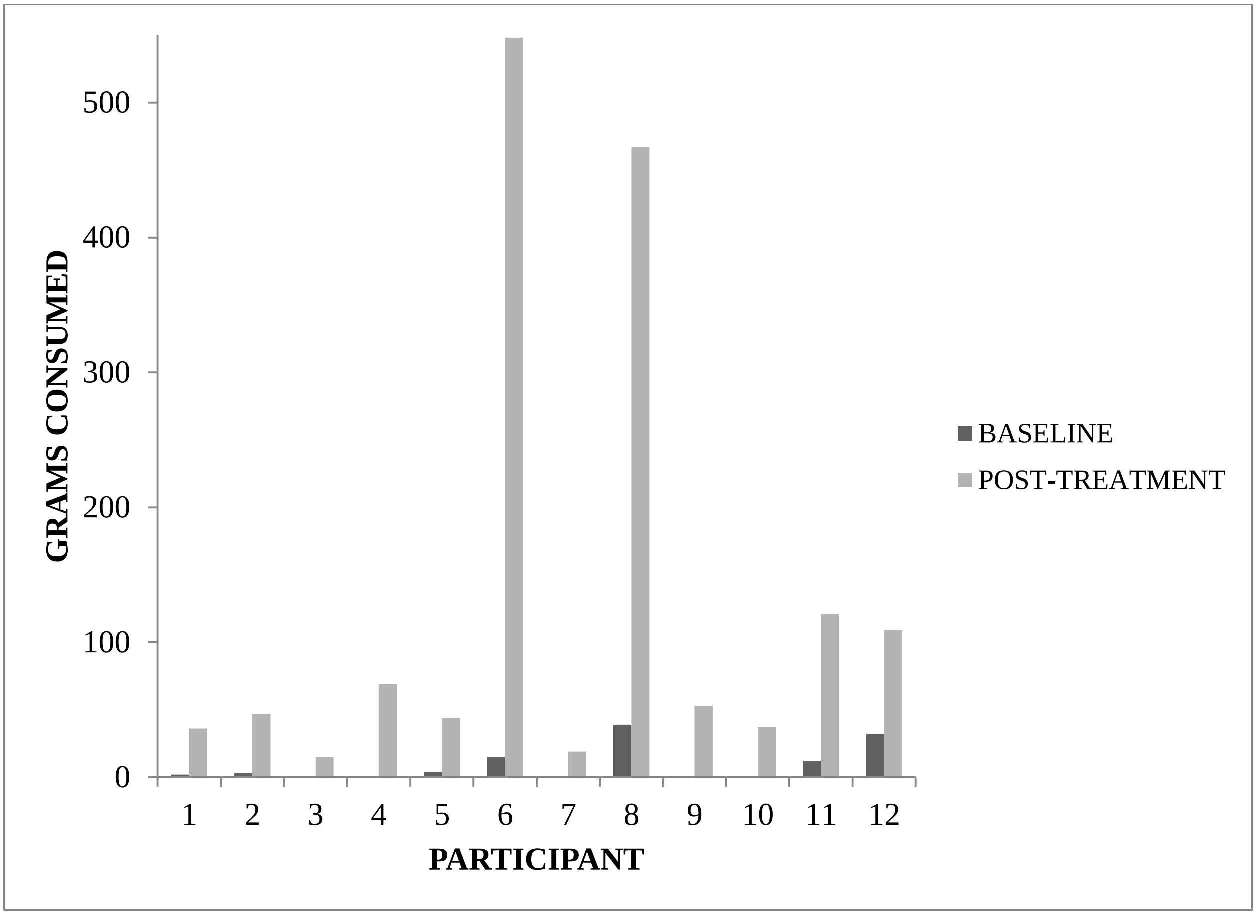


FIGURE 2: Number of grams consumed at baseline and post-treatment during participation in the Pediatric Feeding Program (n = 12), by participant.

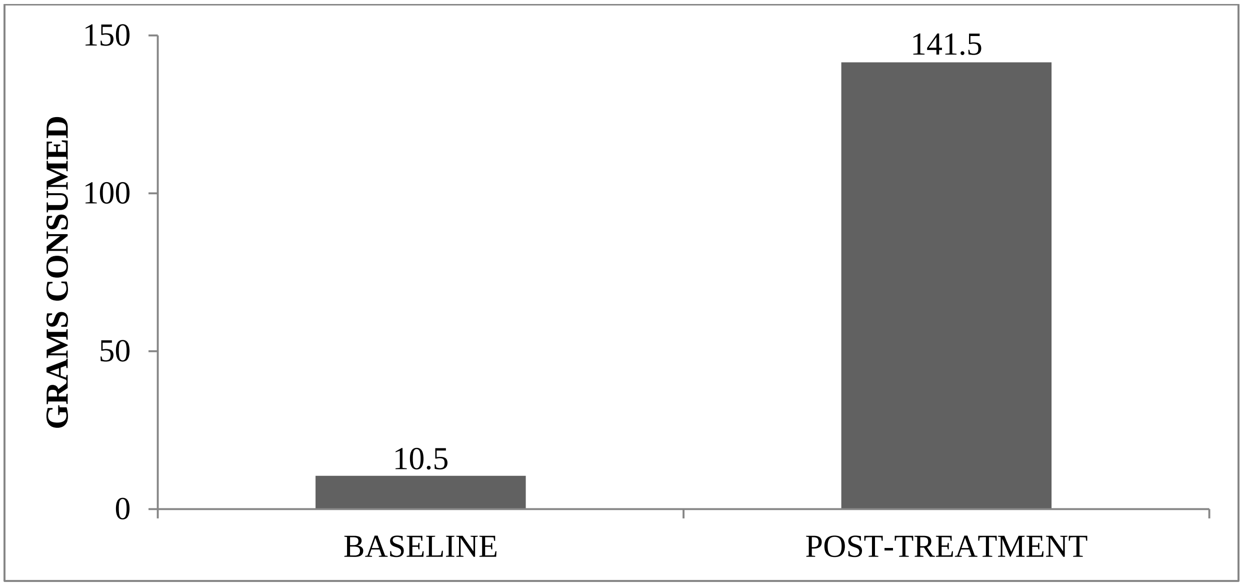


FIGURE 3: Mean number of grams consumed at baseline and post-treatment for participants with food refusal by type (n=4) enrolled in the Pediatric Feeding Program.

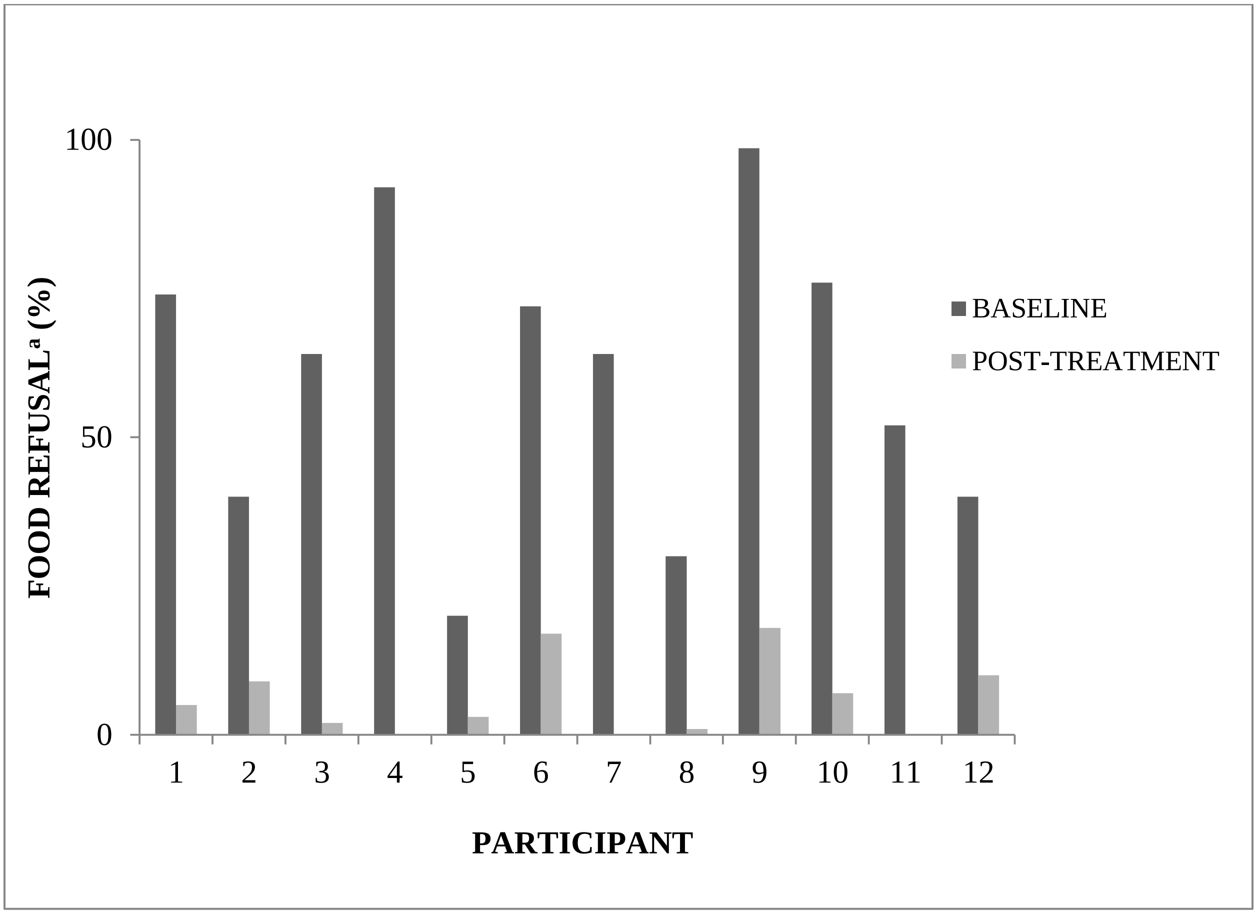


FIGURE 4: Food refusal measure at baseline and post-treatment during participation in the Pediatric Feeding Program (n = 12), by participant.

[a]Food refusal = Percent of offered bites refused

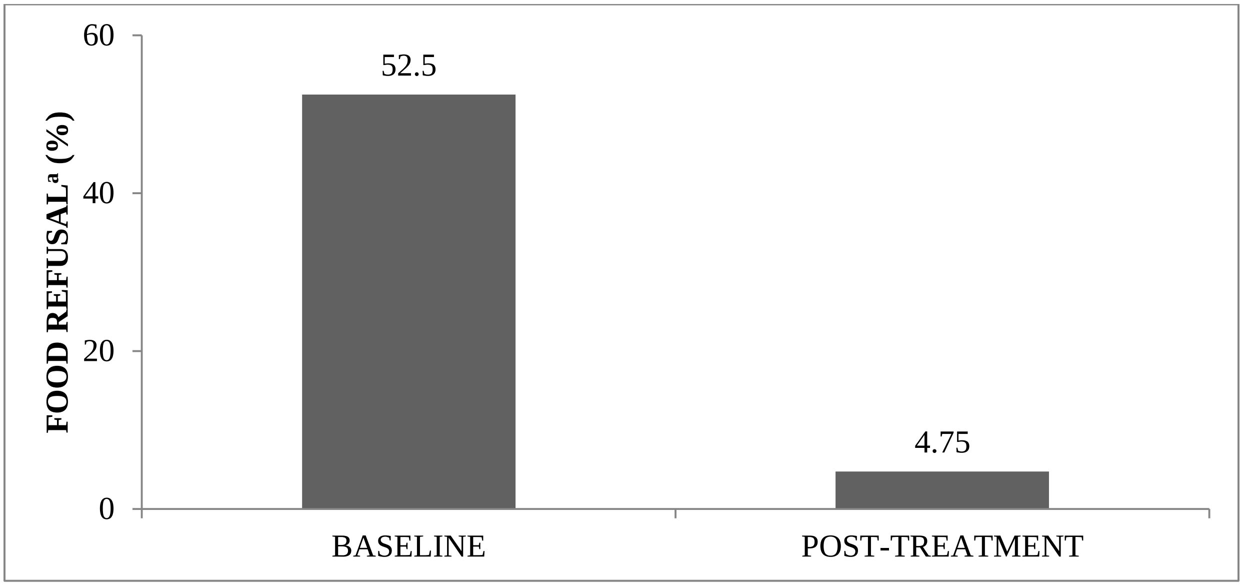


FIGURE 5: Mean food refusal measure at baseline and post-treatment for participants enrolled in the Pediatric Feeding Program with food refusal by type (n=4).

[a]Food refusal = Percent of offered bites refused

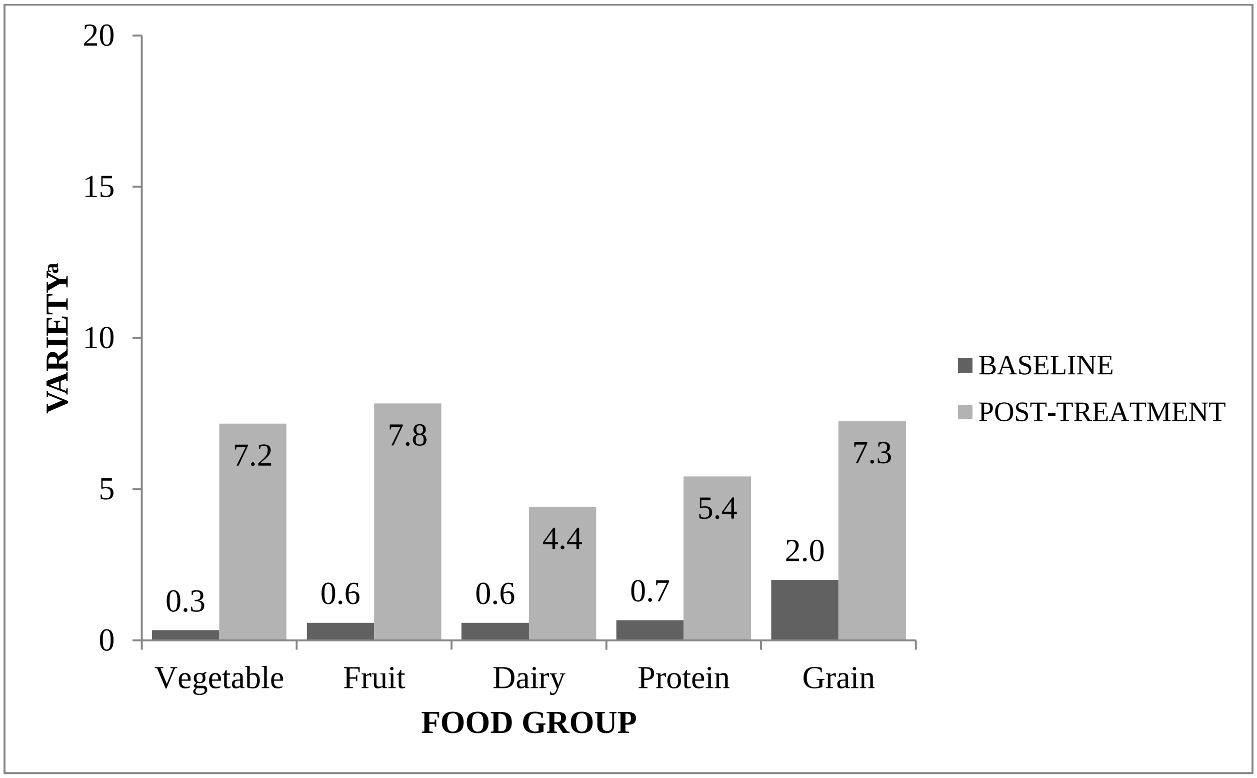


FIGURE 6: Mean variety scores by food group at baseline and post-treatment for all participants (n = 12) enrolled in the Pediatric Feeding Program.

[a]Variety = number of foods accepted

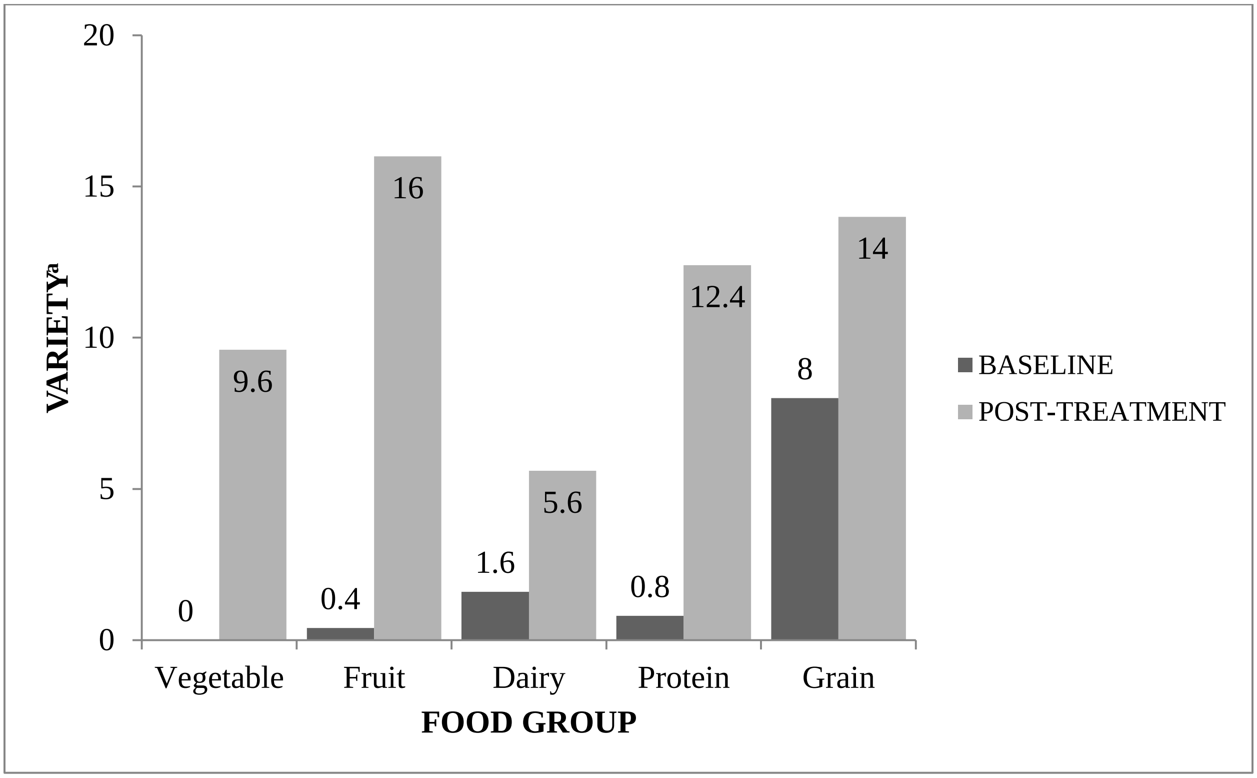
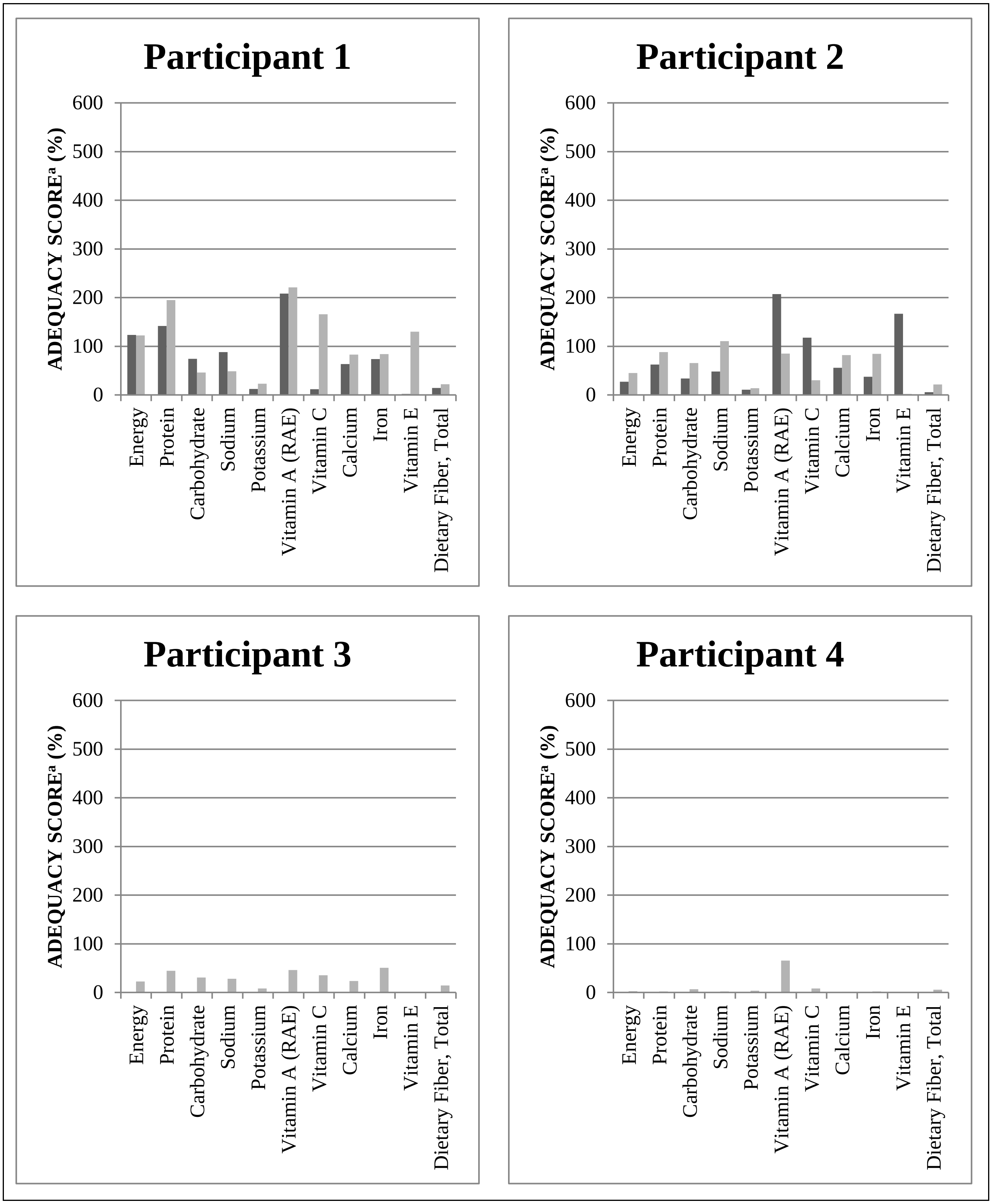
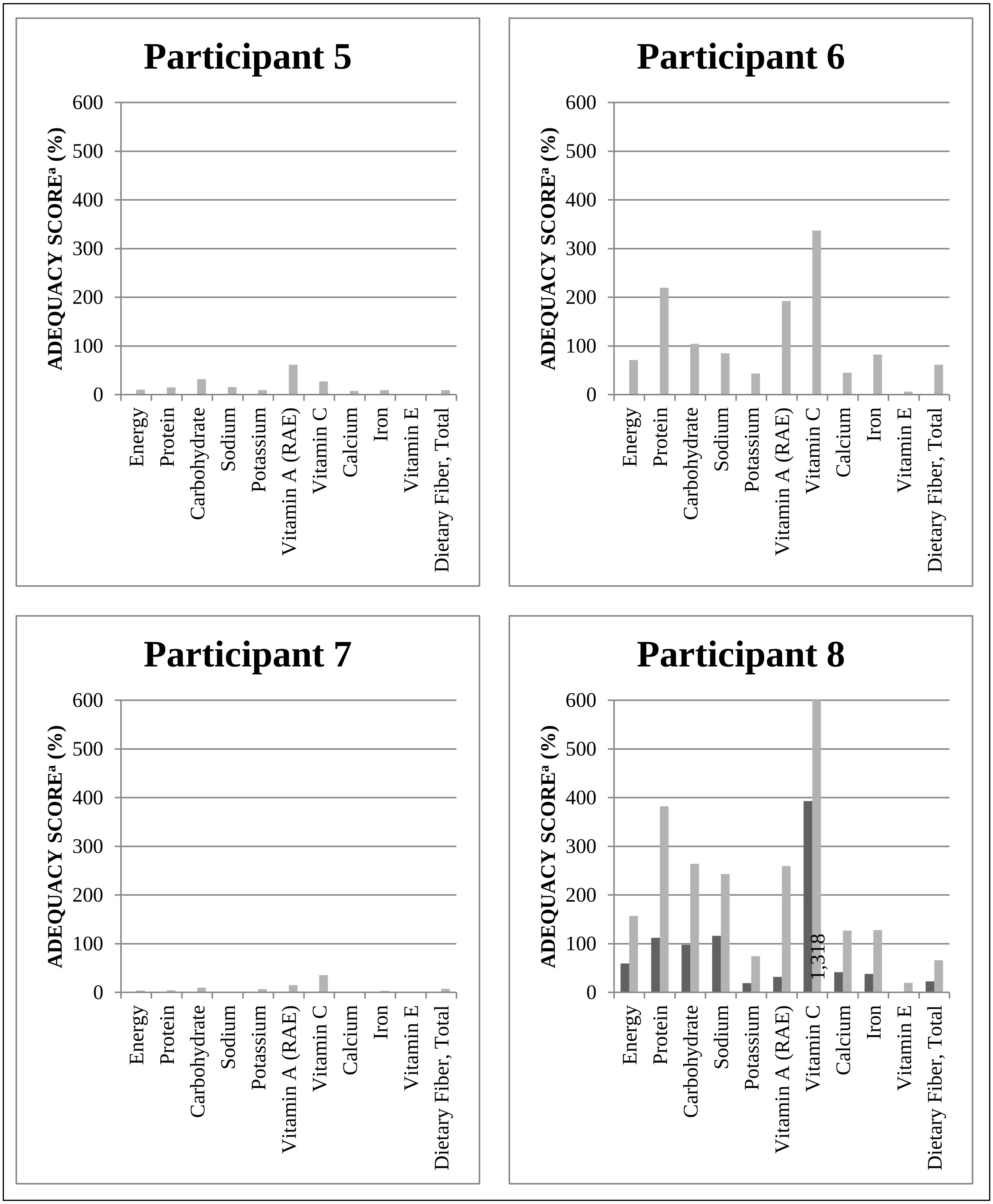


FIGURE 7: Mean variety scores by food group at baseline and post-treatment for participants with refusal by type (n=4) enrolled in the Pediatric Feeding Program.

[a]Variety = number of foods accepted



Participant 1
Participant 2
Participant 3
Participant 4
ADEQUACY SCORE[a] (%)
0
100
200
300
400
500
600
Energy
Protein
Carbohydrate
Sodium
Potassium
Vitamin A (RAE)
Vitamin C
Calcium
Iron
Vitamin E
Dietary Fiber, Total



Participant 5
Participant 6
Participant 7
Participant 8
ADEQUACY SCOREa (%)
600
500
400
300
200
100
0
Energy
Protein
Carbohydrate
Sodium
Potassium
Vitamin A (RAE)
Vitamin C
Calcium
Iron
Vitamin E
Dietary Fiber, Total
1,318

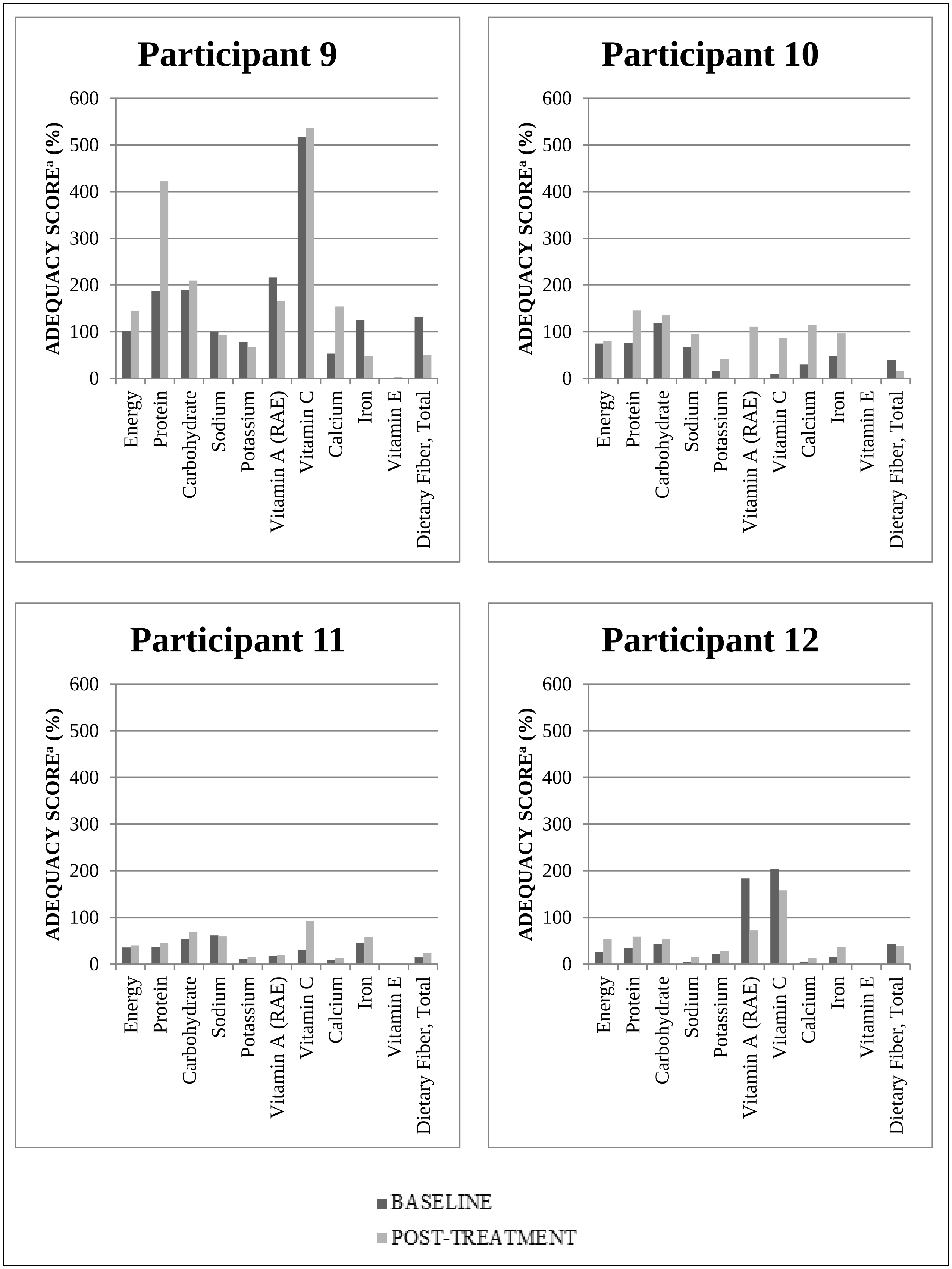

Participant 9
Participant 10
Participant 11
Participant 12
ADEQUACY SCOREa (%)
600
500
400
300
200
100
0
Energy
Protein
Carbohydrate
Sodium
Potassium
Vitamin A (RAE)
Vitamin C
Calcium
Iron
Vitamin E
Dietary Fiber, Total
BASELINE
POST-TREATMENT

FIGURE 8: Nutritional adequacy scores for each nutrient at baseline and post-treatment for each participant enrolled in the Pediatric Feeding Program.

[a]Adequacy Score = Intake as a percentage of two-thirds daily needs based on Institute of Medicine Dietary Reference Intakes[68]

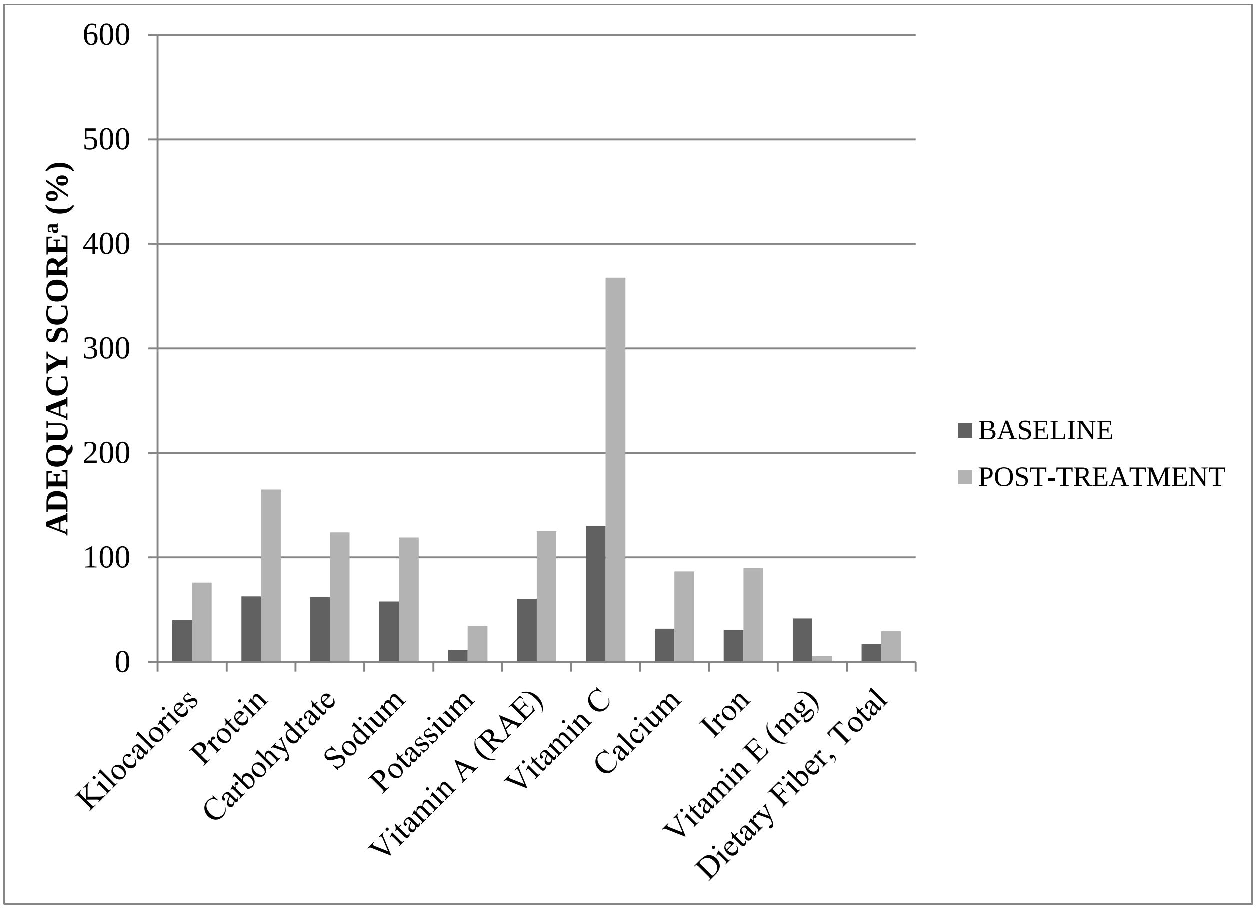


FIGURE9: Mean nutritional adequacy scores for each nutrient at baseline and post-treatment for participants enrolled in the Pediatric Feeding Program with selectivity by type (n = 4).

[a]Adequacy Score = Intake as a percentage of two-thirds daily needs based on Institute of Medicine Dietary Reference Intakes[68]

Table 1: Number of participants enrolled in the Pediatric Feeding Program per food restriction subtype

Demographic	n
Total	12
Food restrictive total	5
Food restriction by type	4
Food restriction by texture	0
Combination food restriction (type & texture)	3
Liquid dependent	5

Table 2: Mean variety scores at baseline and post-treatment for all participants (n=12) enrolled in the Pediatric Feeding Program

Outcome	**Baseline Mean ±SD**	**Post-Treatment Mean ±SD**	***t***	***p*-Value**
Total Variety	4.17 ± 3.71	32.08 ± 18.62	-5.73	p<0.01667
Vegetable	0.33 ± 0.78	7.17 ± 4.73	-5.23	p<0.01
Fruit	0.58 ± 0.79	7.83 ± 5.24	-4.98	p<0.01
Dairy	0.58 ± 0.67	4.42 ± 3.20	-4.28	p<0.01
Protein	0.67 ± 0.98	5.42 ± 4.36	-3.80	p<0.01
Grain	2.00 ± 2.41	7.25 ± 6.57	-3.07	p<0.01

Table 3: Number of Participants within AMDR[a] for Fat as Percentage of Total Kilocalories

Participant	Baseline	Post-Treatment
Participant 1	Y	N
Participant 2	N	N
Participant 3	N	Y
Participant 4	N	N
Participant 5	N	N
Participant 6	N	N
Participant 7	N	N
Participant 8	Y	Y
Participant 9	N	Y
Participant 10	N	N
Participant 11	Y	Y
Participant 12	N	N
TOTAL Y	**3**	**4**

[a]AMDR = Acceptable Macronutrient Distribution Range