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Changes in Energy Intake and Diet Quality During an 18-month Weight Management Randomized Controlled Trial in Adults with Intellectual and Developmental Disabilities

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Abstract

Background—Previous research indicates that individuals with intellectual and developmental disabilities (IDD) are at risk for poor diet quality.

Objective—The purpose of this secondary analysis were to determine if two different weight loss diets affect energy intake, macronutrient intake, and diet quality as measured by the Healthy Eating Index-2010 (HEI-2010) during a 6-month weight loss period and 12-month weight management period, and to examine differences in energy intake, macronutrient intake, and HEI-2010 between groups.

Design—Overweight/obese adults with IDD took part in an 18-month randomized controlled trial and were assigned to either an enhanced stop light diet (eSLD) utilizing portion controlled meals or a conventional diet (CD) consisting of reducing energy intake and following the Dietary Guidelines for Americans. Proxy-assisted 3-day food records were collected at baseline, 6, and 18 months, and were entered into NDSR 2014 for analysis. HEI-2010 was calculated using the data from NDSR.

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Conflict of Interest Disclosure

No conflict of interest

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Participants/setting—The study took place from June 2011- May 2014 in the greater Kansas City Metropolitan area.

Main outcome measures—This was a secondary analysis of a weight management intervention for adults with IDD randomized to an eSLD or CD, to examine differences in energy intake, macronutrient intake, and HEI-2010 across time and between groups.

Statistical analyses performed—Independent- and paired-samples *t*-tests and general mixed modeling for repeated measures were performed to examine group differences and changes at baseline, 6, and 18 months between the eSLD and CD groups.

Results—One hundred and forty six participants (57% female, age = 36.2 ± 12.0 years [mean $\pm$ SD]) were randomized to either the eSLD or CD group (77 eSLD, 69 CD) and provided data for analysis at baseline, 124 completed the 6-month weight loss period, and 101 completed the 18-month study. Participants on the eSLD diet significantly reduced energy intake at 6 and 18 months (both $p < 0.001$) but those on the CD diet did not (both $p = 0.13$). However, when accounting for age, sex, race, education level, and support level (mild vs. moderate IDD), there was a significant decrease over the 18-month intervention in energy intake for the eSLD and CD groups combined ($p < 0.01$ for time effect) but no significant group difference in this change ($p = 0.39$ for group-by-time interaction). There was no significant change in total HEI-2010 score at 6 and 18 months ($p = 0.05$ and 0.38 for the eSLD group; $p = 0.22$ and 0.17 for the CD group), and no significant group difference at 6 and 18 months ($p = 0.08$ and 0.42). However, when participants' age, sex, race, education level, and support level were accounted for, mixed modeling indicated a significant increase in total HEI-2010 scores for the eSLD and CD groups combined over the 18-month intervention ($p = 0.01$ for time effect).

Conclusions—The results of this study found that after controlling for demographic factors, individuals with IDD can decrease their energy intake and increase their diet quality, with no significant differences between the eSLD or CD groups.

Keywords

intellectual and developmental disability; weight management; pre-packaged meals; energy intake; Healthy Eating Index; Stop Light Diet

INTRODUCTION

Approximately 1–3% of the US population is diagnosed with an intellectual or developmental disability (IDD).¹ IDD is defined as a disability characterized by significant limitations in both intellectual functioning ($IQ < 75$) and limitations in 2 or more adaptive behaviors.² The obesity epidemic is of particular concern with this population, because rates of overweight and obesity are higher in this group.^{3,4} Elevated rates of obesity in conjunction with poor diet quality contribute to an increased risk of heart disease, diabetes, hypertension, liver or gallbladder problems, osteoporosis, and depression for individuals with IDD.^{5, 6–8}

As adults with IDD leave institutional care to live in group homes or supported living arrangements, they have more control over their food choices and often have some

responsibilities for acquiring or preparing meals.⁹ Subsequently, adults with IDD have developed many of the poor dietary characteristics of the general population.^{10–12} Additionally, they also can be highly selective eaters, with very restricted repertoires of food acceptance¹³, which may put them at a higher risk of inadequate nutrient intakes and poor diet quality.

The typical diet of adults with IDD is low in fruits, vegetables, fiber, folate, iron, calcium, potassium and zinc, and excessive or high in saturated fat and refined grains.^{14–18} Braunschweig et al¹⁷ reported that the average intake of fruits and vegetables in 89 adults with IDD was 2.8 ± 2.6 and 1.0 ± 1.2 servings per day, respectively, and that no participants consumed the recommended minimum of 5 servings of fruits and vegetables per day. Additionally, when using the Healthy Eating Index-2005 (HEI-2005), overweight and obese adults with IDD were found to have a lower total HEI-2005 score (45.6) compared to the average American (58.2), with lower scores for fruits, vegetables, meat and beans, oils, and sodium.^{18,19}

Healthy People 2020, The US Surgeon General, The Academy of Nutrition and Dietetics, and The World Health Organization recommend additional efforts to improve the diet quality and decrease the high prevalence of obesity among individuals with IDD.^{20–23} However, there is limited evidence on which to base effective dietary interventions.^{24–28} Furthermore, the impact of a weight management (weight loss followed by maintenance) intervention on changes in energy intake and diet quality is unknown. Data from a recently completed 18-month weight management intervention in adults with IDD afforded an opportunity to examine the effect of two different weight loss diets on energy intake, macronutrient intake, and diet quality measured by the Healthy Eating Index-2010 (HEI-2010) during a 6-month weight loss period and 12-month weight management period, and to examine differences between these diets.

METHODS

Overview of study design

This study is a secondary analysis of the dietary outcome data obtained from a recently completed trial. A detailed description of the rationale, design and methods²⁹ and the main outcomes³⁰ have been previously published. Briefly, 150 overweight/obese adults with mild to moderate IDD and a caregiver who agreed to be their study partner to support them during the intervention enrolled into an 18 month effectiveness trial with 6 months of weight loss followed by 12 months of weight maintenance to compare two approaches for weight management. Participants were randomly assigned to either an enhanced Stop Light Diet (eSLD) or a conventional diet (CD). Following the 6-month weight loss period, both groups were encouraged to continue following their diet at a level of energy intake estimated to result in weight maintenance.

Participants

The study took place from June 2011-May 2014 in the greater Kansas City Metropolitan area. Participants were community-dwelling overweight and obese adults, 18 years of age or

older with a diagnosis of mild to moderate IDD as determined by a Community Service Provider operating in the state of Kansas under the auspices of a Community Developmental Disability Organization (CDDO). To be included in the study, participants had to be overweight or obese (BMI $\geq 25\text{kg/m}^2$), reside in a supported living environment either at home or with no more than 4 residents, and have a caregiver who agreed to support them during the program. Individuals were excluded if they had a diagnosis of any of the following conditions: uncontrolled hypertension, severe heart disease, cancer, HIV, severe depression or an eating disorder. Individuals were also excluded if they were on a special diet (e.g. vegan, gluten-free) or had participated in a weight reduction program within the past 6 months. Participants were required to reside within a 50 mile radius of the Kansas City Metropolitan area.

Written informed consent, approved by the IRB at the University of Kansas Medical Center, was obtained from either the participant (self as guardian) or their legal guardian and their study partner. This clinical trial registration number for this study is NCT01724905. Randomization, stratified by sex and by living arrangement (i.e., number of participants in a residence), was completed after both written consent and written physician clearance were obtained. Treatment allocation sequences were generated by computer software using block randomization with equal allocation to the eSLD and CD groups.

Intervention

Overview—All participants were randomized to either the eSLD or CD and assigned a health educator to deliver the intervention via monthly visits. At baseline, the participant and study partner attended a 90-minute at-home diet orientation session conducted by their health educator. Participants were provided detailed instruction on dietary requirements and study protocol. Subsequent monthly follow-up education sessions were conducted during the 18-month intervention in the participants' home.

Weight Loss Diets (Months 0–6)

eSLD: Participants were asked to use the original Stop Light Diet developed by Epstein³¹ which categorized foods by energy content: green (low energy, consume freely), yellow (moderate energy, consume in moderation), red (high energy, consume sparingly). A chart which included lists and pictures of common food items, color coded to the SLD system, was provided to assist with meal planning, food shopping and selection of appropriate snacks. The SLD was enhanced (eSLD) by encouraging consumption of high volume, lower calorie (100–300 kcal), portion-controlled meals (PCMs; entrées/shakes) and fruits and vegetables.³² Participants were asked to consume a minimum daily total of 2 entrées (~200 to 300 kcal each with saturated fat $\leq 3\text{g}$ and sodium $<600\text{mg}$), 2 shakes (~100 kcal each), 5 one-cup servings of fruits and vegetables, and ad libitum non-caloric beverages. Participants and study partners were provided with a list of 50 entrées available from several manufacturers (e.g., Healthy ChoiceTM, Smart OnesTM, Michelina'sTM, etc.) which met the caloric, saturated fat and sodium requirements. Two shakes/day (HMR Weight Management Services Corp) were provided at no cost to participants in the eSLD group during the 6-month weight loss phase. These shakes could be consumed as a breakfast or a snack.

Participants desiring foods in place of or in addition to these recommendations were encouraged to select additional green and yellow foods from the SLD chart.

CD: Participants in the CD group received education to follow the recommendations found on the USDA website ChooseMyPlate.gov,³³ which helps consumers carry out the Dietary Guidelines for Americans.³⁴ Participants' energy needs were estimated using the Mifflin-St Jeor equation³⁵ with an activity factor of 1.4 to 1.6 to account for physical activity. After estimating energy needs a deficit of 500–700 kcal/day was prescribed; however, prescriptions were never less than 1,200 kcals/day. Participants were provided examples of meal plans based on the 2010 MyPlate guidelines³³ suggesting amounts of grains, proteins, fruits, vegetables, dairy, and fats based on their energy needs, and they were counseled on appropriate portion sizes using three-dimensional food models.

Weight Maintenance Diet (months 7 to 12)—Energy intake for weight maintenance for both the eSLD and CD diets was estimated using the equation of Mifflin-St Jeor³⁵ multiplied by 1.4 to 1.6 to account for physical activity. Participants in the eSLD diet were encouraged, but not required, to continue to use 14 PCMS per week, and continue to eat a minimum of 5 fruits and vegetables per day. Participants in the CD diet were provided examples of meal plans consisting of suggested amounts of grains, proteins, fruits and vegetables, dairy, and fats based on their maintenance energy needs.

Physical activity—Participants were encouraged to accumulate a minimum of 30 min./day of moderate-intensity physical activity 5 days/week (150 min./week). Pedometers (Omron HJ-320, Lake Forest, IL) were provided to all participants as both a motivational tool and to self-monitor physical activity. Results showing changes in physical activity have been previously published.³⁰

Weekly tracking and monthly meetings—With assistance from their study partners, participants were asked to complete weekly data recording cards that were specific to their study group (eSLD/CD) throughout the 18-month study. Participants in the eSLD group were asked to check the pictorial representations for the number of entrees, shakes, fruits and vegetables, and other green, yellow or red foods consumed each day. Similarly, participants in the CD group were asked to check the number of daily servings of vegetables, fruits, dairy, meat and grains. The tracking sheets for both groups contained space for recording daily pedometer steps and minutes of non-walking physical activity. All participants were visited once monthly by their health educator. During these monthly home visits the health educator would assess body weight and compliance with the intervention, provide feedback to participants, answer any questions the participant or caregiver had, and problem solve if there were any issues related to following the diet or physical activity goals.

Incentives—Participants received small monetary incentives for recording consumption of foods consistent with the study diets (\$16.00/mo.) and for reducing their BMI by 1 kg/m² (\$10.00). Incentives could be earned during weight loss (0–6 mos.) but not during weight maintenance (7–18 mos.).

Outcomes assessments

Overview—Outcomes were assessed at baseline, 6, and 18 months. All outcomes were assessed at the participant's home during a single visit by study staff blinded to intervention condition.

Demographic data—With the help of a caregiver, basic demographic information (age, race/ethnicity, sex, education level) was collected from participants using a questionnaire at baseline.

Energy and macronutrient intake—Proxy-assisted 3-day food records were obtained to assess the energy and macronutrient content of the diet. Participants and their caregivers were instructed to record all food and beverage consumption on 3 consecutive days (2 weekdays and 1 weekend day). Records were reviewed with the participants and their caregiver by a registered dietitian nutritionist (RDN) who used portion guides to help estimate portion sizes. The portion guides used in the interviews were 3-dimensional models consisting of a variety of items intended to provide a reference and improve recall accuracy (i.e., glasses, mugs, bowls, circles, thickness sticks, chip bags, drink bottles, a 12-inch ruler, measuring cups and spoons, a grid, wedges, geometric shapes, and diagrams of chicken pieces).³⁶ Records were removed from analysis if the RDN felt that the record could not be considered reliable (participant forgot one or more meals, or claimed they could not remember anything consumed that day). The records were entered into the Nutrient Data System for Research (NDS-R; University of Minnesota, Minneapolis, MN; version 2014)^{37,38} for analysis.

Diet Quality—The Healthy Eating Index-2010 (HEI-2010) was used to calculate diet quality from data obtained from the 3-day diet records at baseline, 6, and 18 months. The HEI-2010 is a measure of diet quality developed by the United States Department of Agriculture and the National Cancer Institute that assesses conformance to the 2010 Dietary Guidelines for Americans.³⁹ The HEI-2010 provides a point value based on how well a person meets the dietary guidelines.⁴⁰ The HEI-2010 was calculated using NDS-R output and a custom SAS code. Point values for each component were summed to give the final HEI score. The total maximum score for HEI-2010 is 100. Total fruit, whole fruit, total vegetables, greens and beans, total protein foods, and seafood and plant proteins all have a maximum score of 5 points. Whole grains, dairy, fatty acids, refined grains, and sodium have a maximum score of 10 points. Empty calories have a maximum score of 20 points. Higher component scores are generally indicative of higher consumption of those foods; however, the scoring for refined grains, sodium, and empty calories is inverted with higher scores being given to indicate lower consumption of those components.

Statistical Analysis—This was a secondary analysis of a weight management intervention for adults with IDD, and thus was not powered to detect differences in energy intake, macronutrient intake, and HEI-2010 scores. Descriptive statistics were calculated to summarize sample demographics and all outcome measures. Independent-samples *t*-test (with Satterthwaite approximation, if necessary) was performed to examine group differences at baseline, 6 and 18 months between the eSLD and CD groups, and paired-

samples *t*-test was performed to examine changes at 6 and 18 months in each group. In addition, general linear mixed modeling for repeated measures was utilized to estimate overall group difference (i.e., group effect), linear change from 0 to 18 months (three time points; i.e., time effect), and group difference in this change (i.e., group-by-time interaction) for each outcome, accounting for age, sex, race, education level, and support level. Statistical significance was determined at 0.05 alpha level, and all analyses were conducted using SAS 9.4 (SAS Institute, 2013–2016).⁴¹

RESULTS

Participants

A total of 150 individuals enrolled in the weight management program, 124 completed the weight loss period, and 101 completed the 18-month study. Of those 150 individuals, 146 participants provided a valid 3-day food records at baseline and were included for analysis. Full demographic data for the 146 participants are presented in Table 1.

Energy intake

Absolute energy intake (kcal/d) over the 18-month intervention is presented in Table 2. There was no significant group difference in absolute energy intake at baseline ($p = 0.42$). Those on the eSLD diet significantly reduced energy intake at 6 and 18 months (both $p < 0.001$) but those on the CD diet did not (both $p = 0.13$). Consequently, the eSLD group consumed significantly less energy compared to the CD group at 6 months ($p = 0.01$) and 18 months ($p = 0.02$). However, this finding was not confirmed by mixed modeling results when accounting for age, sex, race, education level, and support level (mild vs. moderate IDD). When using mixed modeling, there was a significant decrease over the 18-month intervention in energy intake for the eSLD and CD groups combined ($p < 0.01$ for time effect) but no significant group difference in this change ($p = 0.39$ for group-by-time interaction). There were significant effects of age ($p = 0.01$) and sex ($p < 0.01$).

Macronutrient intake

Macronutrient intake at baseline, 6 and 18 months in both the eSLD and CD groups is presented in Table 2. There was no significant group difference in intake of carbohydrate, fat, or protein expressed as either g/day or as a percentage of energy intake at baseline. Those on the eSLD diet significantly reduced carbohydrate and fat intakes (g/day) at 6 and 18 months (all $p < 0.001$) but those on the CD diet did not ($p = 0.05$ and 0.09 for carbohydrate; $p = 0.37$ and 0.39 for fat). Consequently, the eSLD group consumed significantly fewer grams of carbohydrate and fat compared to the CD group at 6 and 18 months (all $p < 0.05$). In addition, those on the eSLD diet significantly reduced fat intake and increased protein intake as percentages of energy intake at 6 months (both $p < 0.0001$) while those on the CD diet made no significant changes ($p = 0.65$ for fat; $p = 0.41$ for protein), resulting in significant group differences at 6 months (both $p < 0.01$). However, these differences between groups were not confirmed by mixed modeling results when accounting for age, sex, race, education level, and support level (mild vs. moderate IDD). When using mixed modeling, carbohydrate, fat, and protein intakes (g/day) significantly decreased over the 18-month intervention for the eSLD and CD groups combined (all $p <$

0.05 for time effect). However, these changes did not differ between groups ($p = 0.45, 0.57$, and 0.27 for group-by-time interaction). There were significant effects of age for fat ($p=0.03$) and carbohydrate intake ($p=0.02$), and significant effects of sex for fat ($p<0.01$) carbohydrates ($p=0.03$) and protein ($p=0.01$).

HEI-2010

HEI-2010 total score was significantly greater in the CD group than the eSLD group at baseline (49.2 ± 12.2 vs. 44.9 ± 11.0 ; $p = 0.03$). The total score increased by 3.2 ± 12.2 and 2.1 ± 12.0 at 6 months in the eSLD and CD groups, respectively. Scores further increased by 1.4 ± 10.4 in the eSLD group but decreased by 2.6 ± 11.2 in the CD group at 18 months. However, those changes were not significant ($p = 0.05$ and 0.38 for the eSLD group; $p = 0.22$ and 0.17 for the CD group), and there was no significant group difference at 6 and 18 months ($p = 0.08$ and 0.42). At baseline, all HEI-2010 component scores were comparable between groups, except total fruit score and whole fruit score that were significantly higher in the CD group compared to the eSLD group (both $p = 0.01$). While the CD group did not make any significant changes in the component scores, the eSLD group showed significantly increased scores at 6 and 18 months for whole fruits (both $p = 0.02$), total vegetables (both $p = 0.02$), and sodium ($p < 0.001$ and 0.01). At 6 months, the CD group had significantly greater total fruit, whole grains, and fatty acids scores compared to the eSLD group ($p = 0.02, 0.04$, and 0.02). No significant group differences were found at 18 months. Mixed modeling showed that after controlling for age, sex, race, education level, and support level, there was a significant increase in HEI-2010 total score over the 18-month intervention for the eSLD and CD groups combined ($p = 0.01$ for time effect) but this change was not different between groups ($p = 0.17$ for group-by-time interaction). Similarly, there was a significant improvement over time in each of whole fruits, total vegetables, sodium, and empty calories scores for the eSLD and CD groups combined (all $p < 0.05$ for time effect) but these changes did not differ between groups ($p = 0.37, 0.10, 0.10$, and 0.48 for group-by-time interaction). Full HEI-2010 results are shown in Table 3.

DISCUSSION

There have been few weight management interventions for adults with IDD, and those published do not report changes in energy intake, macronutrient intake, and diet quality. Diets that score highly on the HEI-2010 are associated with improved health markers,^{42,43} and a recent meta-analysis⁴⁴ observed a significant reduction in the risk of all-cause mortality, cardiovascular disease, cancer, and type 2 diabetes mellitus by 22%, 22%, 15%, and 22%, respectively, with increased HEI scores. Improvements in diet quality may reduce the risk of these conditions independently from benefits seen with weight loss. Because changes in dietary quality have independent effects on health, it is important to assess and prescribe changes in dietary intake beyond just recommendations for weight management. This may be particularly important in those with IDD, as the rates of chronic disease are higher in this population, exacerbating their impact on quality of life.^{8,11,45}

Both the eSLD and CD diet prescriptions were aimed at providing an estimated energy deficit of 500–700 calories a day during the weight loss portion of the intervention. While

participants in both diet groups reduced their energy intake, only the eSLD group showed a significant reduction in energy intake. The eSLD group had ~300 kcal/day greater energy intake deficit compared to the CD group. However, when accounting for demographic factors, participants as a whole (both diet groups combined) significantly decreased their energy intake, with no difference between groups. The mixed modeling results determine that age and sex have an effect on changes in energy intake in adults with IDD. This effect of age and sex could be why no significant change across time was seen in the CD during the original analysis.

There was concern that participants would return to their baseline dietary habits and energy intake after discontinuing the PCMs. Instead, the results found that when participants were no longer required to consume PCMs during weight maintenance, they did slightly increase energy intake (~100 kcal/d); however, their energy intake remained lower than baseline.

Diet quality did not significantly change during the 6-month weight loss and 18-month weight maintenance period, and there were no differences between diet groups. However, there was a significant change across time for both groups combined when controlling for demographic factors. Thus, like energy intake, individual demographic factors may play a role in changes in diet quality in adults with IDD. Interestingly, the baseline scores of adults with IDD are similar to those of the general population; 49.8 in men and 52.7 in women.³⁹ Furthermore, the changes in diet quality are similar to those seen in weight loss interventions in the general population.^{46,47} These results suggest that adults with IDD may have similar food choices, eating behaviors, and responses to weight loss diets as those seen in adults with normal cognitive development.

Strengths of the current study include the use of a randomized design, a long-term weight management intervention over 18-months, a large sample, the inclusion of both men and women, and a rigorous assessment of dietary intake and diet quality during both weight loss and weight maintenance. However, while the results are encouraging, this study should be considered in the context of certain limitations. First, the main intervention was not specifically designed or powered to detect between or within group differences in energy intake or HEI-2010 scores. Secondly, while 3-day food records have previously been used in this population,¹⁴ dietary assessment in individuals with IDD presents a challenge, as many have compromised cognitive functioning, poor memory, and a shortened attention span, which may impact the validity of the records. In order to help mitigate this limitation, the participant's home-staff members were asked to help fill out records over the three-day period. Additionally, after the records were completed, a RDN reviewed the food records with the participant and their staff member. Furthermore, researchers have not yet validated a method for dietary intake assessment in adults with IDD due to the significant barriers to collecting accurate data in this group.⁹ Finally, although the intervention used a randomization scheme, those randomized to the CD had a significantly higher total HEI-2010 score at baseline compared to those randomized to the eSLD, which may limit the generalizability of the results. However, despite the baseline differences there was no difference in change across time between the two intervention groups.

As previously mentioned, the results for total energy intake, micronutrient intake, and intake of several of the HEI-2010 components that were obtained without accounting for any covariates were different than those obtained when mixed modeling accounted for demographic factors such as age, sex, race, education level and support level was used. Sex and age were found to be common demographic characteristics that were found to have significant effects on the data. Thus, these results suggest that age and sex of the individual may need to be taken into consideration. Future research is needed to determine how sex and age affect dietary changes and how to better tailor diet recommendations based on demographic characteristics.

CONCLUSION

The results of this study found that on a population wide level, individuals with IDD can decrease their energy intake and increase their diet quality when enrolled in a weight management intervention. When controlling for demographic characteristics, there were significant changes across time for energy intake, micronutrient intake, and diet quality for all groups combined, but no significant differences between the eSLD or CD groups. More research is needed to determine the role of demographic characteristics such as sex and age on changes in energy intake, micronutrient intake, and diet quality for adults with IDD.

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Table 1

Baseline characteristics of adults with Intellectual and Developmental Disabilities, living in the Kansas City Metropolitan area, randomized to an Enhanced Stop Light Diet or Conventional Diet between 2011 and 2014.

Characteristic	All Participants (N = 146 ^b)		Enhanced Stop Light Diet ^a (n = 77 ^b)		Conventional Diet ^a (n = 69 ^b)	
	n	%	n	%	n	%
Age (yr) (Mean ± SD)	146	36.2 ± 12.0	77	36.0 ± 12.0	69	36.5 ± 12.1
Sex						
Male	63	43.2%	31	40.3%	32	46.4%
Female	83	56.8%	46	59.7%	37	53.6%
Race/Ethnicity						
Hispanic	4	2.7%	2	2.6%	2	2.9%
Non-Hispanic White	119	81.5%	64	83.1%	55	79.7%
Non-Hispanic Black or African American	18	12.3%	8	10.4%	10	14.5%
Native Hawaiian/Pacific Islander	0	0.0%	0	0.0%	0	0.0%
Asian	2	1.4%	1	1.3%	1	1.4%
American Indian/Alaska Native	1	0.7%	1	1.3%	0	0.0%
Two or more races	2	1.4%	1	1.3%	1	1.4%
Education level						
<9th grade	5	3.4%	3	3.9%	2	3.0%
9th–12th grade	21	14.4%	10	13.0%	11	15.9%
High school graduate/GED	92	63.0%	50	65.0%	42	54.5%
Post graduate classes or higher	28	19.1%	14	18.2%	14	20.3%
BMI (kg/m ²) (Mean ± SD)	146	37.0 ± 7.8	77	37.5 ± 7.6	69	36.4 ± 8.1

^aNo significant differences between groups

^bRepresents participants who provided a valid 3-day food record at baseline

Mean energy and macronutrient intake per day across 18 months for adults with Intellectual and Developmental Disabilities, living in the Kansas City Metropolitan area, randomized to an Enhanced Stop Light Diet or Conventional Diet between the years of 2011 and 2014.

Table 2

Enhanced Stop Light Diet (n = 77)				Conventional Diet (n = 69)			Group difference
Variable	n	Mean	SD	n	Mean	SD	p
Intake							
Energy (kcal)							
Month 0	77	1752.8	533.3	69	1846.7	817.7	0.42 <i>a</i>
Month 6	57	1285.5	398.7	51	1585.7	756.7	0.01 <i>a</i>
Month 18	49	1381.4	477.7	38	1613.9	372.6	0.02 <i>b</i>
Fat (g)							
Month 0	77	67.2	24.4	69	71.4	39.5	0.45 <i>a</i>
Month 6	57	43.3	22.0	51	61.4	36.8	<0.01 <i>a</i>
Month 18	49	49.9	25.9	38	60.9	21.8	0.04 <i>b</i>
Carbohydrate (g)							
Month 0	77	216.2	81.9	69	233.6	103.9	0.27 <i>a</i>
Month 6	57	163.1	60.0	51	194.9	91.8	0.04 <i>a</i>
Month 18	49	175.1	59.8	38	202.6	60.6	0.04 <i>b</i>
Protein (g)							
Month 0	77	76.0	27.3	69	74.8	30.7	0.79 <i>b</i>
Month 6	57	66.8	23.8	51	68.5	29.6	0.74 <i>b</i>
Month 18	49	63.1	23.1	38	69.8	21.8	0.17 <i>b</i>
Percent Energy from Fat (%)							
Month 0	77	34.1	6.5	69	33.8	6.8	0.79 <i>b</i>
Month 6	57	28.5	10.0	51	33.8	6.4	<0.01 <i>a</i>
Month 18	49	30.9	8.5	38	33.0	7.8	0.23 <i>b</i>
Percent Energy from Carbohydrate (%)							
Month 0	77	49.5	8.1	69	51.0	7.8	0.27 <i>b</i>

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Enhanced Stop Light Diet (n = 77)						Conventional Diet (n = 69)			Group difference
Variable	n	Mean	SD	n	Mean	SD		p	
Month 6	57	52.1	11.9	51	49.7	8.0		0.21 ^a	
Month 18	49	51.6	10.0	38	50.7	10.4		0.68 ^b	
Percent Energy from Protein (%)									
Month 0	77	17.6	3.6	69	16.8	3.8		0.24 ^b	
Month 6	57	21.3	5.4	51	18.0	4.3		<0.01 ^b	
Month 18	49	19.1	5.4	38	17.9	4.5		0.28 ^b	

^a p value from independent-samples *t* test with Satterthwaite approximation

^b p value from independent-samples *t* test

Table 3

Healthy Eating Index-2010 (HEL-2010) component scores across 18 months for adults with Intellectual and Developmental Disabilities, living in the Kansas City Metropolitan area, randomized to an Enhanced Stop Light Diet or Conventional Diet between the years of 2011 and 2014.

Score	Enhanced Stop Light Diet (n = 77)			Conventional Diet (n = 69)			Group difference
	n	Mean	SD	n	Mean	SD	
Total HEL-2010							
Month 0	77	44.9	11.0	69	49.2	12.2	0.03 ^a
Month 6	56	48.9	11.5	51	52.8	10.9	0.08 ^a
Month 18	48	49.8	11.7	38	51.7	10.0	0.42 ^a
Total fruit							
Month 0	77	1.5	1.6	69	2.2	1.7	0.01 ^b
Month 6	56	1.9	1.7	51	2.7	1.8	0.02 ^a
Month 18	48	2.0	1.7	38	2.5	1.7	0.16 ^a
Whole fruit							
Month 0	77	1.6	1.7	69	2.4	1.8	0.01 ^a
Month 6	56	2.4	1.9	51	2.9	1.9	0.18 ^a
Month 18	48	2.5	1.9	38	2.9	1.9	0.28 ^a
Total vegetables							
Month 0	77	2.5	1.3	69	2.9	1.3	0.06 ^a
Month 6	56	3.4	1.4	51	3.1	1.4	0.29 ^a
Month 18	48	3.2	1.5	38	3.0	1.4	0.50 ^a
Greens and beans							
Month 0	77	0.7	1.1	69	0.7	1.0	0.89 ^a
Month 6	56	1.0	1.6	51	0.8	1.2	0.54 ^a
Month 18	48	0.9	1.2	38	0.7	1.0	0.47 ^a
Refined grains							
Month 0	77	5.5	2.7	69	6.2	2.4	0.07 ^a
Month 6	56	5.8	2.7	51	6.0	2.8	0.65 ^a

Enhanced Stop Light Diet (n = 77)		Conventional Diet (n = 69)			Group difference		
Score	n	Mean	SD	n	Mean	SD	p
Whole grains							
Month 18	48	5.6	2.8	38	5.8	2.7	0.73 ^a
Dairy							
Month 0	77	4.0	3.1	69	4.6	3.1	0.26 ^a
Month 6	56	3.1	3.3	51	4.4	2.8	0.04 ^a
Month 18	48	3.8	3.1	38	4.6	3.1	0.21 ^a
Total protein foods							
Month 0	77	5.3	3.1	69	4.9	2.4	0.37 ^a
Month 6	56	5.0	2.9	51	5.2	2.8	0.74 ^a
Month 18	48	5.7	3.1	38	5.5	2.8	0.80 ^a
Seafood & plant proteins							
Month 0	77	1.1	1.4	69	1.5	1.5	0.16 ^a
Month 6	56	0.9	1.2	51	1.0	1.4	0.56 ^a
Month 18	48	1.1	1.4	38	1.5	1.5	0.24 ^a
Fatty acids							
Month 0	77	4.8	2.6	69	5.3	2.8	0.25 ^a
Month 6	56	4.8	2.6	51	6.0	2.3	0.02 ^a
Month 18	48	4.9	2.5	38	5.9	2.6	0.07 ^a
Sodium							
Month 0	77	0.7	1.3	69	0.9	1.6	0.49 ^b
Month 6	57	2.0	2.9	52	1.0	2.1	0.05 ^b
Month 18	50	1.8	2.7	40	0.9	2.4	0.11 ^a
Empty calories							

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Enhanced Stop Light Diet (n = 77)							Conventional Diet (n = 69)		Group difference	
Score	n	Mean	SD	n	Mean	SD	n	Mean	SD	p
Month 0	77	13.2	4.8	69	13.6	4.4				0.56 ^a
Month 6	56	14.9	4.4	51	15.5	4.4				0.45 ^a
Month 18	48	14.8	4.2	38	14.8	4.2				0.99 ^a

^a p value from independent-samples t-test
^b p value from independent-samples t-test with Satterthwaite approximation