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Feasibility of a hospital-based, family-centered intervention to reduce weight gain in overweight children and adolescents☆

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Abstract

Objective: To evaluate the effects of a hospital-based, family-centered lifestyle program (Kids N Fitness©) on weight and health in overweight 7–17-year-old children.
Design: The Kids N Fitness© program consisting of up to twelve 90-min sessions was conducted in an outpatient setting. The program comprised interactive nutrition and exercise sessions with behavior modification. Subjects completed a logbook and child's health questionnaire. Measures and surveys were taken before, during, and after the program.
Participants: Two hundred and sixty-four overweight children (137 female, 73% Hispanic), mean age 11.5 ± 2.1 years, with body mass index (BMI) = 85th percentile, no physical limitations, and attendance of ≥50% of sessions. A subgroup of 115 children was observed for up to 6 months prior to program.
Intervention results: Weight and BMI velocity, and BMI, and BMI *z*-score were lower during the program than during the pre-program observation period. Compared, subjects in the 12-week program had significantly reduced gains in weight and greater losses in body mass index, than in 8 weeks. Improvements in emotional well-being and behavior correlated positively with weight loss ($p = 0.005$).
Conclusions: Positive health outcomes suggest that family-centered programs, stressing healthy eating strategies, participation in team-oriented physical activities, and behavior modification, are effective in improving weight dynamics and psychological functioning.

Keywords: Weight loss; BMI reduction; Obesity; Children; Adolescents; Family; Intervention

1. Introduction

Significant increases in obesity and type 2 diabetes are occurring across all age groups and ethnicities nationwide. Approximately one out of five children is now considered overweight or obese [1]. Both genetic and environmental factors contribute to obesity. While

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approximately 80% of the offspring of overweight parents will become overweight, only 14% of offspring of two lean parents will become obese [2,3]. Predisposing environmental factors include excessive calorie consumption and decreased or inadequate physical exertion. Overweight children are more likely to become obese adults than are normal weight children [4]. Additionally, overweight children may experience psychological stress, poor body image, low self-esteem, feelings of shame and embarrassment, and other health problems [5].

The goals of treating overweight children are to decrease body weight, optimize body composition, improve well-being and lifestyle, and prevent potential complications such as diabetes and heart disease. Outcomes of various existing pediatric weight loss programs are difficult to compare due to differences in nutrition and behavior education, amount of prescribed exercise activity, and level of parental involvement. In outpatient settings, nutrition management, without a simultaneous exercise and behavior modification program, frequently fails as demonstrated by Pinelli et al. in a multi-center adult obesity treatment study [6]. Appropriately, the most dramatic short-term weight improvements are achieved in inpatient settings and camps where access to food is limited and exercise is mandatory [7]. However, while this type of treatment results in acute weight loss children must eventually face the trying challenge of maintaining their weight loss upon returning home. For long-term success in weight loss and weight loss maintenance, programs that include participation of a parent or caregiver as an integral component are generally more successful. Flodmark et al. demonstrated significant improvements in BMI in a number of severely obese 10–11-year-old children participating in a weight management intervention involving dietary counseling, exercise guidelines, and family therapy [8]. Epstein reported that participants in a child and parent weight management program demonstrated significantly greater decreases in percent overweight 5 and 10 years post-intervention (-11.2% and -7.5%, respectively) than a child-only group, or a group with variable family participation [9].

In an attempt to treat children at risk for overweight (BMI >85th percentile for age) and overweight (BMI >95th percentile for age), our center established a family-centered weight management program, KNF, in 1998, involving nutritional education, family therapy, and exercise activities. The theoretical framework behind this program was that lifestyle enhancement and family involvement would improve children's health.

We hypothesized that our weight management program would improve the lifestyle of the child and the family in order to achieve better weight controls. The study was designed to determine if changes in subjects' eating behaviors and physical activity, through participation in KNF, resulted in a significant decrease in weight velocity while in the program. Further, the study was designed to determine if there were significant changes in other variables, such as healthy food intake, exercise activity, and sense of well-being. A number of subjects were evaluated for presence of metabolic syndrome and results are published elsewhere [10].

2. Subjects and methods

2.1. Subjects

Subjects were referred to the program by our hospital staff, community physicians, school health personnel, or by self-referral. There was no charge to participate. Each child was required to be accompanied by a parent, grandparent, or legal guardian. All participants and parents signed informed consents prior to study enrollment. Eligibility criteria for program entrance included the following: (1) 7–17 years of age, (2) weight for height ≥85th percentile on the Center for Disease Control (CDC) growth charts, and (3) no physical limitations preventing regular exercise. Individuals were excluded from participation if they were non-ambulatory, undergoing rigorous medical therapy, or due to other medical conditions noted by their physician.

Approximately 20 subjects enrolled in each session and there were on average four sessions each year. Over 6 years, 417 overweight or at risk for overweight children enrolled into KNF.

2.2. Program design

In 1998, KNF began as an 8-week, eight-session intervention. After a preliminary analysis, it was determined that an 8-week intervention did not provide an ample amount of time for instruction to achieve expected outcomes. Beginning in the fall of 2002, the program was extended to 12 weeks. Due to space, staff, and resource limitations, 115 subjects had to wait up to 6 months prior to program commencement before beginning the program. Their data, obtained during registration for the program, were used for the calculation of weight and BMI velocities during the pre-program period.

At enrollment, all subjects chose a personalized exercise and/or nutrition goal to work on throughout the program and were encouraged toward the achievement of their goal(s) by program staff. During the program, participants were also asked to complete the KNF logbook© three times and an exercise activity sheet twice at set intervals in an effort to reinforce positive lifestyle changes.

Pre- and post-program measures included weight, height, BMI, resting blood pressure, 2-h oral glucose tolerance test (OGTT), fasting serum insulin, and total cholesterol, triglycerides, HDL, LDL, and a child health questionnaire (CHQ) [11].

Each week, subjects would attend a 90-min session at the commencement of which heights and weights were measured. Sessions consisted of three components: exercise, nutrition education/behavior modification, and family involvement. Exercise sessions were led by registered dietitians and physical therapists, and lasted approximately 45 min. Exercise activities varied in each session and included intervals, dancing, walking, exercise videos and modified sports resembling soccer, hockey, and volleyball. The modifications were made such that all participants were continually active. In modified soccer, for instance, multiple balls were employed. Exercise activities were tailored to our facility. Parents did not participate in the exercise portion due to the inability to reliably provide or reasonably attain medical clearance. Alternatively, during the exercise portion of the session, parents were taught the implications of obesity in children and adults, and the importance of supportive environments and healthy lifestyles for their children and themselves. Simultaneous Spanish translation was provided by the Language Service or a staff volunteer.

Following the exercise, a 45-min nutrition education/behavioral modification session was presented to both subjects and parent(s). Nutrition counseling explained the importance of the food guide pyramid, food-label reading, appropriate portion sizes, techniques for dining-out, minimizing sugar and cholesterol consumption, understanding key nutrients and additives in a variety of foods. One session entailed a local supermarket excursion demonstrating food-label reading. Nutrition education was taught by registered dietitians. Behavior modification sessions taught families lifestyle habits to promote health, such as encouraging exercise at least three times weekly for a minimum 30-min' duration as well as to follow the healthy diets taught during the sessions. Behavior modification sessions were led by physicians and social workers. Simultaneous Spanish translation was provided for these sessions as well.

Subjects were asked to record their daily dietary and exercise activity during the first, fourth, and seventh weeks of the 8- and 12-week programs to ensure consistency between programs. Subjects recorded activities in their KNF logbook©. The logbooks contained seven multiple choice questions related to frequency of snacks and dessert, such as candy, cookies, chips, and cake; fatty foods, such as fried foods and butter; snack intake; skipped meals; and fruit and vegetable consumption; along with minutes of exercise. In addition, during the second and seventh sessions of the program, subjects were asked to specifically record the type, duration, and intensity of exercise performed during that week. This measure was intended to instruct subjects about the intensity of different activities and to determine whether exercise duration or intensity increased over time. Parents were asked to verify each day that data were recorded to ensure their involvement and promote accurate responses. This measure was intended to help subjects identify diet and exercise behaviors, which may have a negative impact on weight management goals. Based on scored responses, subjects were given strategies on ways to target and change unhealthy behaviors by program staff.

The extended 12-week program included instruction on eating ample fruits and vegetables through a discussion of the "five-a-day" concept, appropriate fiber intake, energy balance, and carbohydrate pacing. Additional exercise activities comprised repetitions of activities performed during the 8-week session.

Follow-up sessions were offered monthly on a continual basis for interested families. Subjects were called and sent reminder invitations to attend these sessions, which were similar in format with the exception that the nutrition component lasted only 15 min. This format was chosen to allow more time for exercise and team building among return participants. The nutrition component was designed to reinforce core nutrition concepts, offer nutrition tips, and provide resources that would enable families to select, prepare, and consume healthier foods. Occasional take-home activities were assigned which included, for example, comparing food container labels at home for fiber content.

2.3. Measures

2.3.1. Anthropometry/blood pressure

Subjects' weight measurements were obtained to the nearest 0.1 kg using a Detecto electronic weight scale that was calibrated daily. Heights were measured in 0.1 cm increments using a Harpenden stadiometer (City, UK). BMI values and associated z-scores were calculated using Epi Info software developed by the CDC (CDC, Version 3.2.2, Atlanta, GA). Monthly rates of weight and BMI change (weight and BMI velocities) were calculated based on two measurements taken at the beginning and end of the described period. The end of one period coincided with the beginning of the next period (i.e., the end of the pre-program period is equivalent to the beginning of the program period). Participants' anthropometric variables were measured at the commencement of each visit. Blood pressure was obtained at enrollment and at the first and final visits of the study using an automated blood pressure device (BRAND, City ST). Approximately one certified staff member was available for every ten children requiring measurements of height, weight, and blood pressure.

2.3.2. Child health questionnaire (Landgraf)

Parents/caregivers were asked to complete a validated CHQ at enrollment and at program completion. Comprising nine sections, the CHQ examines physical and psychosocial factors that may reflect or have some effect on the overall health status of children. Each section consists of questions evaluating the general topic of the section and some sections were further subdivided into subsections. The response to each question was scaled. The sections cover topics including the child's general health, ability to perform physical activities; limitations on performing everyday activities imposed by problems with behavior, emotions, or physical health; bodily pain or discomfort; behavior; self-esteem, as well as the

parent's degree of concern and the family's cohesion and limitations on time, needs, and activities due to the child's difficulties. Lastly, the CHQ contains questions regarding the parent's current employment, marriage status, ethnicity, and educational background. Ethnicity classifications were defined by parents' responses in the CHQ. Ethnicity was assessed to determine if there were ethnic differences in response to the lifestyle intervention.

Internal consistency reliability of the 11 multi-item scales (91%) met or exceeded the minimum standard for group level analyses of 0.70; the median reliability estimate was 0.84 and evidence of validity was supported through multiple health outcome studies [11].

2.3.3. Laboratory

Laboratory methods for measurements of glucose, insulin, c-peptide, hemoglobin A1c, leptin, cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides have been described previously [10].

2.3.4. Cost

Cost was assessed for children in the 12-week program by measuring fixed costs (sports equipment and facilities), variable costs (recruitment, consenting, nutrition consultation, anthropometrics, materials, review and grading of logbooks, and related staff costs), and semi-variable costs (physical therapists and nutritional education). Semi-variable costs were calculated over the average number of sessions attended.

3. Statistics

All data are presented as mean ± S.D. Descriptive statistics were used to evaluate the participants' demographic characteristics throughout the study, such as age, height, weight, and BMI. Pearson correlation were used to describe associations between changes in weight and BMI, and other variables for those subjects that attended a minimum of 50% of the sessions of the program. Paired *t*-tests were used to compare weight and BMI velocities and related outcome measures before, during and after program participation. Non-paired *t*-tests were used to compare similar measures between 8- and 12-week program participants. A *p*-value of <0.05 was deemed significant.

4. Results

Of the 417 subjects initially enrolled in the program, 264 subjects (63%) attended at least half of the sessions and constitute the study cohort (Fig. 1). There were 137 female and 127 male subjects. Subjects had a mean age of 11.66 ± 2.19 years (range 7.5–17.4). There were 92 subjects older than 12 years, but majority was less than 12 years old. The majority of subjects were Hispanic (73%); 12% were African American, 8% were Caucasian, and 7% were of some other ethnicity. There were 180 participants in the 8-week and 84 participants in the 12-week program. Those in the 8-week program ($n = 160$) attended an average of 6.87 ± 1.39 sessions and those in the 12-week program ($n = 84$) attended an average of 8.95 ± 1.78 sessions. At baseline, the subjects who enrolled in the 8-week program were not significantly different from those in the 12-week program in terms of mean age, percentage of ethnic groups, BMI, and BMI *z*-score (Table 1). A subgroup of 115 children and adolescents were observed for up to 6 months prior to the program (mean ± S.D. of 3.15 ± 1.33 months) and served as their own controls for both 8- and 12-week programs. This group did not differ from those who began the program immediately after enrollment in terms of age, gender, ethnicity, initial BMI or BMI *z*-score (Table 1, Fig. 1).

There were statistically significant decreases in BMI, BMI *z*-score, weight and BMI velocities, and rate of BMI *z*-score change in subjects ($n = 115$) in the whole study population when compared to values obtained during the immediate pre-program period. Weight velocity during the program decreased from 0.726 ± 0.980 to 0.193 kg/month ($p < 0.001$), and BMI velocity decreased form 0.228 ± 0.452 to -0.061 ± 0.548 kg/m^2/month ($p < 0.001$). BMI *z*-score rate (change in *z*-score per month) improved from 0.011 ± 0.042 to -0.001 ± 0.003 *z*-score/month ($p = 0.006$).

While participating in the program, subjects in the 12-week program compared to those in the 8-week program had significantly reduced weight gains (0.14 ± 2.01 kg versus 0.81 ± 2.32 kg, $p = 0.026$) and significantly greater BMI losses (-0.41 ± 0.85 kg/m^2 versus 0.08 ± 0.98 kg/m^2, $p < 0.001$). However, changes in BMI *z*-scores were not significantly different between the two programs (-0.04 ± 0.06 in the 12-week program and -0.02 ± 0.10 in the 8-week program). BMI velocity was again significantly lower in the 12-week program (-0.15 ± 0.30 compared to 0.01 ± 0.50 kg/m^2/month, $p = 0.002$) (Table 2, Fig. 2).

Over all, changes in weight, BMI, weight and BMI velocities, and BMI *z*-scores did not correlate with subjects' age, gender, or ethnicity. Older than 12 years subjects ($n = 92$) had greater improvement in weight velocity during the program participation, compared to less than 12 years old ($n = 172$), but the difference did not reach statistical significance. There were no significant differences in the degree of weight and/or BMI *z*-score change between participants with higher versus lower BMI *z*-score at the baseline.

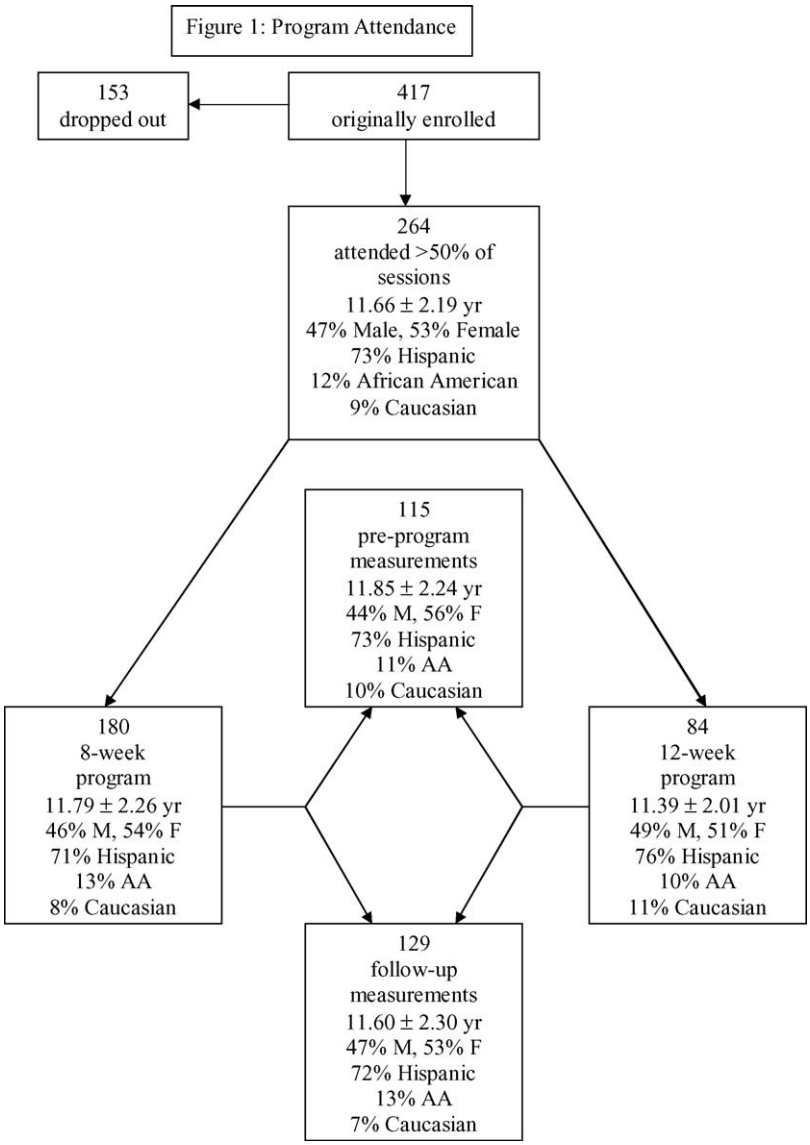

Fig. 1. Demographic data are presented for subjects participating in various subcategories of the KNF program. M = male, F = female, and AA = African American.

In subjects enrolled in the 12-week program, there were no significant differences between the dropouts ($n = 153$) and those who completed the program ($n = 264$). Female participants were more likely to attend a greater number of sessions ($p = 0.03$). Session attendance was inversely associated with weight and BMI velocities ($r = -0.225$, $p < 0.05$ and $r = -0.237$, $p < 0.05$, respectively) and change in BMI z-score ($r = -0.340$, $p < 0.005$).

According to parents' responses to the CHQ, there were significant improvements in their child's perceived health and physical function relative to 1 year prior in 8-week, but not in 12-week program ($p = 0.044$ versus $p = 0.242$; and $p = 0.019$ versus 0.136). The 12-week group, but not the 8-week group showed less limitations to perform physical activities including soccer, running, climbing stairs, bending, and getting in and out of bed; ability to complete school work or participate in activities with friends in spite of problems with physical health ($p = 0.002$ versus 0.297). Both populations demonstrated significantly improved amount of bodily pain or discomfort ($p < 0.001$ and $p = 0.032$) and behavior ($p < 0.001$ and $p = 0.043$) and improvement in self-perceived health and well-being ($p = 0.003$ and 0.025) over the program period. Family cohesion improved in the 12-week program ($p = 0.044$), but there

Table 1
Comparison of demographic and outcome data between 8- and 12-week programs

	8 weeks		12 weeks	
	n	Mean	*n*	Mean
Pre-program				
Age (years)	74	12.15 (2.42)	41	11.31 (1.77)
Female	74	58%	41	51%
Hispanic	67	73%	41	73%
African American	67	13%	41	7%
Caucasian	67	7%	41	10%
Other	67	7%	41	10%
Months enrolled	74	3.52 (1.31)	41	2.49 (1.11)
Weight (kg)	74	78.6 (22.7)	41	78.6 (21.6)
BMI (kg/m^2)	67	32.7 (6.2)	41	33.6 (7.7)
BMI *z*-score	67	2.30 (0.49)	41	2.40 (0.31)
Change in BMI *z*-score	66	0.052 (0.197)	41	0.001 (0.039)
Weight velocity (kg/month)	74	0.834 (1.05)	41	0.531 (0.821)
BMI velocity (kg/m^2/month)	67	0.252 (0.489)	41	0.190 (0.387)
BMI *z*-score rate	66	0.014 (0.050)	41	0.006 (0.024)
Baseline				
Age (years)	180	11.79 (2.26)	84	11.39 (2.02)
Female	180	54%	84	51%
Hispanic	166	71%	84	76%
African American	166	13%	84	10%
Caucasian	166	8%	84	7%
Other	166	8%	84	7%
Weight (kg)	180	77.8 (23.2)	84	77.1 (23.9)
BMI	180	32.9 (6.8)	84	33.2 (7.3)
BMI *z*-score	180	2.33 (0.40)	84	2.38 (0.34)
Follow-up				
Age (years)	112	11.62 (2.33)	17	11.46 (2.15)
Female	112	52%	17	59%
Hispanic*	106	69%	17	94%
African American	106	14%	17	6%
Caucasian*	106	8%	17	0%
Months*	112	10.4 (10.7)	17	4.79 (4.51)
Weight velocity (kg/month)	112	0.600 (0.991)	17	0.252 (0.855)
BMI velocity (kg/m^2/month)	105	0.109 (0.431)	17	−0.080 (0.384)

* Indicates a significant difference in variable between 8- and 12-week programs; $p < 0.01$. Standard deviation in parentheses.

were no significant changes in family time spent together, and spent in activities. Program had a positive impact on parents in both groups, with statistically significant difference in 8-week group ($p = 0.027$) (Table 3). Of note, not all participants had answered all questionnaire items both, pre- and post-program.

Significant improvements in emotional well-being and behavior were present in older than 12 years

Table 2
Comparison of weight and BMI characteristics during the study between 8- and 12-week programs

Characteristic	8 weeks		12 weeks		*p**
	n	Mean	*n*	Mean	
Weight gains (kg)	180	0.81 (2.32)	84	0.14 (2.01)	0.026
BMI gains (kg/m^2)	180	0.08 (0.98)	84	−0.41 (0.85)	<0.002
Weight velocity (kg/month)	180	0.29 (1.11)	84	0.04 (0.74)	0.150
BMI velocity (kg/m^2/month)	180	0.01 (0.50)	84	−0.15 (0.30)	0.002
BMI *z*-score	180	−0.02 (0.10)	84	−0.04 (0.06)	0.060

* Statistical significance of difference between 8- and 12-week programs. Standard deviation in parentheses.

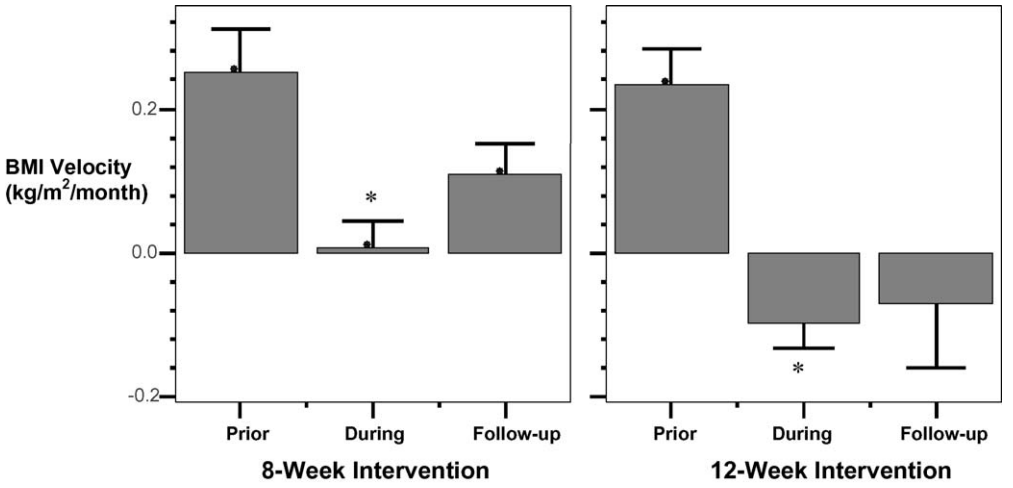

Fig. 2. BMI velocities before, during, and after KNF program. Error bars show mean ± 1.0 S.E. $^{*}p = 0.002$.

children ($p = 0.009$) and in those subjects who entered the study with higher BMI z-scores ($p = 0.025$), as well as in those who lost more weight ($p = 0.005$).

One hundred twenty-nine subjects who attended at least half of the sessions of the 8- or 12-week programs elected to participate in the follow-up program. The average follow-up duration was 9.64 ± 10.25 months (range 0.23–49.12). In 8-week program average duration was 10.4 ± 10.7 months, compared to 4.79 ± 4.51 months in 12-week group. Of these, 56 and 49 had pre-program weight and BMI growth rates measured, respectively. After completing KNF, in 8-week group weight velocity increased significantly to 0.60 ± 0.99 kg/month compared to 0.29 ± 1.11 kg/month observed during the program ($p = 0.032$), and the same trend was observed in the 12-week group: 0.25 ± 0.85 kg/month versus 0.04 ± 0.74 kg/month ($p = 0.079$). The BMI velocity increased compared to program participation, but not significantly (Fig. 2). Subjects' post-program follow-up weight and BMI velocities remained less than their corresponding pre-program rates, however, these differences were not significant.

Follow-up session attendance was positively correlated with program session attendance ($r = 0.224$, $p = 0.042$) and inversely correlated with BMI velocity during follow-up ($r = -0.201$, $p = 0.026$). There was also an inverse relationship between age and follow-up weight gain velocity ($r = -0.191$, $p = 0.030$).

The average amount of money spent per child in the 12-week program for fixed, semi-variable, and variable costs related to his or her participation in KNF was US$ 327.43.

5. Discussion

The KNF program was designed as an ambulatory intervention and set in an urban, academic children's hospital. Patients and families were referred from various outpatient departments within the hospital, community pediatricians, and school personnel. The goal was to provide children and families interactive, activity-based education aimed at improving eating habits, increasing after-school physical activity, and modifying unhealthy behaviors through participation in weekly group sessions and completion of take-home activities. The curriculum was designed to maximize active participation by subjects in a group setting, and, thus, did not include individual sessions with a child or child–parent unit. Similarly, a study by Goldfield et al. in 2001 found that a family-based behavioral intervention employing group treatment alone to be a more cost-effective approach to treating childhood obesity than was a mixed group plus individual format [12].

Our results suggest that an 8–12-week intervention program comprising nutrition education, exercise, and family and behavior components can significantly reduce weight velocity in a cohort of pre- and post-pubertal children with baseline BMI >85th percentile. Those who attended a greater number of sessions experienced a more pronounced decrease in weight and BMI velocities and a greater reduction in BMI z-scores. Accordingly, those in the 12-week program experienced a greater absolute change in BMI and associated z-score.

While absolute BMI losses and relative weight velocity reductions were clearly observed during the

Table 3
Comparison of CHQ responses before and after program

	8-week program				12-week program			
	Mean	*n*	(S.D.)	*p*	Mean	*n*	(S.D.)	*p*
Parent survey general health pre*	62.4	108	25.5	0.044	61.8	35	24.8	0.242
Parent survey general health post	66.9	108	23.1		64.9	35	24.6	
Physical function pre*	76.5	110	26.6	0.019	74.4	38	24.5	0.136
Physical function post	82.7	110	22.4		81.7	38	23.9	
Limited behavior pre	76.9	112	30.6	0.541	78.9	39	26.0	0.513
Limited behavior post	83.9	112	26.6		82.9	39	28.2	
Limited emotional pre	79.9	111	30.3	0.535	77.8	39	30.5	0.335
Limited emotional post	86.4	111	23.6		83.2	39	27.6	
Limited physical pre*	80.1	111	29.3	0.297	77.5	39	28.9	0.002
Limited physical post	85.8	111	24.8		91.9	39	16.7	
Bodily pain pre**	73.3	112	24.2	<0.001	77.3	38	22.4	0.032
Bodily pain post	80.8	112	22.5		84.1	38	18.5	
Behavior pre**	70.7	111	18.8	<0.001	69.7	36	18.5	0.043
Behavior post	77.0	111	16.1		75.5	36	17.0	
Mental health pre*	71.6	112	18.6	0.021	73.4	39	17.2	0.927
Mental health post	75.0	112	15.6		73.5	39	15.3	
Self-esteem pre	74.0	112	21.2	0.334	73.0	39	19.3	0.166
Self-esteem post	75.0	112	23.0		77.0	39	23.4	
Perceptions pre*	58.8	112	15.0	0.035	59.1	38	14.7	0.217
Perceptions post	61.3	112	14.8		61.9	38	11.8	
Change in health pre**	3.4	111	1.2	0.003	3.5	38	1.1	0.025
Change in health post	3.8	111	1.0		4.0	38	1.0	
Parent impact emotional pre*	51.2	111	31.8	0.027	49.3	39	30.4	0.917
Parent impact emotional post	58.2	111	32.6		49.9	39	31.0	
Family activities pre	77.1	111	21.4	0.348	78.8	39	17.7	0.489
Family activities post	80.7	111	20.0		80.9	39	19.1	
Family cohesion pre*	72.7	110	24.7	0.676	67.3	39	22.6	0.044
Family cohesion post	75.5	110	22.2		76.5	39	20.4	
Time pre	76.5	110	83.2	0.168	78.6	39	22.1	0.855
Time post	83.2	110	23.7		79.5	39	26.4	

n varies, depending on number of completed questionnaire items.
* $p < 0.05$ in one study population.
** $p < 0.05$ in both study populations.

program period, these benefits did not appear to be completely sustainable during follow-up months neither in 8-week nor 12-week program. As expected, increases in 12-week group were lesser than in the 8-week group. There appeared to be a trend, however, toward reduced BMI and weight velocities during the follow-up period compared to velocities prior to program enrollment. Moreover, older than 12 years subjects, and those who attended more sessions during the program had lower BMI velocities during the follow-up period. It is likely that older children have a greater capacity to comprehend and grasp the information presented to them and more potential opportunities to make greater lifestyle choices. Also, those who attended a greater number of sessions could have been more motivated, or had more motivated parents, and therefore, the opportunity to gather a greater breadth of knowledge and to experience a more consistent regimen aiding in successful maintenance of a healthy lifestyle.

Overall, parents' perceptions of their child's health and well-being improved over the course of the program. According to the parents, children appeared healthier, more capable, more active, and more behaved during the program participation. Despite of the

positive trend in both populations, only 8-week group showed significant improvement in mental health score, but the emotional limitations and self-esteem did not significantly improve. As expected, greater improvements in emotional well-being were seen in older subjects and in those who lost more weight during the program. Furthermore, in the 12-week program, there were significant improvements in family cohesion. The 12-week program provided parents and subjects an opportunity to spend more time with one and another, and to participate and learn in a greater number of activities. An 8-week period of time may be too short to expect greater cohesiveness between family members.

The major limitation of this study was the low subject retention rate. Poor session attendance was noted in both the 8- and 12-week programs, with a greater number of dropouts in the 12-week program. Poor retention is a common phenomenon in many healthy-living programs in both children and adults [13,14]. However, our study faced added challenges to retention: the majority of study subjects were of relatively low socioeconomic status, subjects were not given monetary incentives, subject and parent(s) had to commute to the hospital during rush hour every week, and sessions often coincided with school breaks and summer vacations. Among other reasons for not completing the program, families listed lack of transportation and language limitations, despite use of translators and bilingual educational materials. The program was also limited by a lack of outdoor activity space and the follow-up program was completely voluntary and may have comprised more motivated individuals.

The 12-week group had much shorter average duration of post-program follow-up, therefore, the post-program weight and BMI sustenance results may need to be interpreted with some reservation. It is also possible that the subjects who had favorable weight dynamics during the study, remained in study for greater number of sessions as opposed to youth who saw no immediate improvement, and our findings may be biased with anthropometric data obtained from more successful youth.

These observations suggest a potential role for a mobile weight management program or community-based program that would allow greater access to interventions such as this one, especially in high-risk communities. In contrast to our hospital-based program, a permanent community-based/school program where subjects can continually meet on a regular basis throughout childhood would provide the needed structure, feedback, and positive reinforcement essential for success in healthy lifestyle maintenance. Additional treatment strategies are also needed for families with overweight children who are not able, ready, or motivated to participate in a weight management program.

Our program costs were covered by research funding. Insurance reimbursements were not available for KNF group sessions and most families were not able to afford to pay to participate. Therefore, in the community setting, a lack of funds is a serious obstacle for creating similar family-centered weight management programs.

In conclusion, the KNF weight management program helped children reduce and maintain healthier weight velocities over time. In light of epidemic levels of childhood obesity, supportive programs that offer children and their families an opportunity to learn appropriate eating behaviors and promote physical activity with peers in a non-threatening atmosphere may prove beneficial in reducing further rapid weight gain that may lead to adulthood obesity and associated health risks.

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