A Family-Based Approach to Preventing Excessive Weight Gain

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Abstract

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Objective: Preventing weight gain in adults and excessive weight gain in children is a high priority. We evaluated the ability of a family-based program aimed at increasing steps and cereal consumption (for breakfast and snacks) to reduce weight gain in children and adults.

Research Methods and Procedures: Families (n = 105) with at least one 8- to 12-year-old child who was at-risk-for-overweight or overweight (designated as the target child) were recruited for the study. Eighty-two families were randomly assigned to receive the family-based intervention and 23 families to the control condition. The 13-week intervention consisted of specific increases in daily steps (an additional 2000 steps/d) and consumption of 2 servings/d of ready-to-eat cereal.

Results: The intervention was successful in increasing walking (steps) and cereal consumption. The intervention had positive, significant effects on percentage BMI-for-age and percentage body fat for target children and weight, BMI, and percentage body fat for parents. On further analysis, the positive effects of the intervention were seen largely in target girls and moms, rather than in target boys and dads.

Discussion: This family-based weight gain prevention program based on small changes holds promise for reducing excessive weight gain in families and especially in growing overweight children.

Key words: weight gain prevention, children, families, steps, cereal

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Introduction

Obesity is a leading cause of preventable deaths in the U.S. (1). The current epidemic of obesity has arisen from a gradual weight gain that appears to have affected all segments of the population over the past 3 to 4 decades (2) and shows no signs of abating. Children have not been immune, and it is estimated that childhood obesity has tripled in the last 40 years (3).

Although there is agreement about the urgent need to address the epidemic of obesity, there is not agreement about how to do this. Past efforts to produce and maintain weight loss have not been overly successful, either in obese adults or children (4–6). Many experts believe we may have more success in preventing obesity than in reversing it once it is established. However, few, if any, programs have been shown to be effective for preventing weight gain or obesity.

We (2) recently analyzed the pattern of weight gain over time in the adult population and concluded that over the past decade, the average American adult has gained 1 to 2 pounds per year. We further hypothesized that this weight gain is due to sustained, slight positive energy balance. Based on this analysis, we calculated that weight gain could be prevented in 90% of the adult population by modifying energy balance (some combination of decreased energy intake and increased energy expenditure) by only 100 kcal/d. Although this analysis was based on weight gain in the adult population over time, we believe a similar situation holds for children in that they are gaining excessive weight, weight gain in excess of that required for optimum growth. We hypothesize that this excessive weight gain in children is also due to a sustained, slight positive energy balance.

Similar to the adult population, excessive weight gain might be prevented or reduced in children by making small, achievable lifestyle changes.

Small behavior changes are likely to be more achievable in the population as opposed to the larger changes required to achieve permanent weight loss. For this reason, reducing weight gain in adults and children should be a major public health goal. Our work in this area led to the development of America on the Move (AOM),[1] a national program to prevent weight gain in adults and prevent excessive weight gain in children through promotion of small increases in steps and small decreases in energy intake (7).

Prevention of childhood overweight is critical because long-term outcome data for successful treatment approaches are limited. Pediatric expert committees continue to report that efforts are urgently needed to effectively intervene with families and children who are at-risk-for-overweight or are already overweight. The purpose of this study was to determine whether an intervention consisting of small lifestyle changes aimed at all members of a family was feasible and whether it could positively affect eating and walking and weight gain over time in children who were at-risk-for-overweight or overweight (defined as ≥85th percentile BMI-for-age) (8) and their parents. We chose two small lifestyle changes to use in the intervention. The first was to increase walking by 2000 steps/d. We have previously shown in adults that we can use electronic step counters (pedometers) to achieve such increases in walking in most participants (9). The second was to consume 2 servings/d of ready-to-eat cereal. One serving was to be consumed for breakfast and the other for a snack. Eating breakfast has been consistently associated with better weight management. It is one factor that successful weight loss maintainers have in common (10), and it has been associated with reduced total daily caloric intake (11). Cereal consumption has also been suggested as a small factor that can help in weight loss (12). Because snack foods are often high in fat, we asked participants to replace a usual daily snack with one serving of cereal.

Research Methods and Procedures

Study Design

We randomly assigned 105 families to the experimental (EXP; $n = 82$) or control (CON; $n = 23$) groups. After a 7-day baseline period, families were studied for 13 weeks. Each member of those families assigned to the EXP group was asked to make two small lifestyle changes consisting of: increasing their daily walking by 2000 steps/d above baseline levels and consuming 2 servings/d of ready-to-eat cereal, one at breakfast and one for a snack. Each member of those families assigned to the CON group was asked to maintain their usual eating and step patterns throughout the study. We compared outcome measures during Weeks 2 to 14 with the baseline values and examined differences between groups in the changes.

Participants and Selection Criteria

Families were recruited from the Fort Collins, CO area by printed flyers and e-mail advertising. Eligible families had at least one 8- to 12-year-old child who was classified as at-risk-for-overweight or overweight (≥85th percentile BMI-for-age) who would participate with at least one parent or guardian. Each child who met this criterion was designated as a target child. A family was defined as two or more individuals who resided in the same household and who had some common emotional bond. Other family members were also encouraged to participate in the study.

All participants read and signed an informed consent (adults) or assent (children) form approved by the University of Colorado Health Sciences Combined Multiple Institutional Review Board and the Colorado State University Human Research Committee. Parental consent was obtained for all minors who participated in the study.

After completing a telephone screening and orientation, all interested participants completed a demographic and health history questionnaire. The target child's height and weight were measured by the research staff before study enrollment to insure that they met the criterion of being at-risk-for-overweight or overweight. If the family met the inclusion criteria, they were invited to participate in the study and were randomly assigned to the EXP or CON group.

Intervention

All EXP and CON families were provided with step counters (Accusplit AE120; Accusplit, San Jose, CA). Additionally all EXP and CON families were provided with group-specific step and cereal logs and instructed on their use. All family members were asked to record their daily steps and cereal servings consumed.

CON families were asked to maintain their usual eating and step patterns throughout the 14-week study. All CON families attended three group meetings (at the beginning, middle, and end of the study) with a member of the research team. These sessions were used to take measurements, collect family data on steps and cereal servings, answer questions, and encourage continued participation in the study. Additionally, each CON family was asked to have someone drop off the family steps per day and cereal consumption data at the end of Weeks 3 and 10 of the study.

EXP families were asked to maintain their usual eating and step patterns for the first week of the study to establish a baseline and then to make two specific lifestyle changes. First, each participating family member was asked to in-

[1] Nonstandard abbreviations: AOM, America on the Move; EXP, experimental; CON, control.

crease walking by at least 2000 steps/d above his or her individual baseline level. They were encouraged to continue to gradually increase steps per day as much as possible. Second, each participating family member was asked to consume 2 servings cereal/d, one at breakfast and one for a snack. EXP families were provided free cereal (Kellogg's ready-to-eat cereals). EXP families were also provided with fun, creative, family-oriented, educational logs to record steps per day and cereal servings consumed per day. The logs used cartoon characters, the Organ Wise Guys (Wellness Inc., Atlanta, GA), to provide fun, motivational ways to increase steps and reminders to eat cereal and record information in the logs.

EXP families also met with study staff on three occasions (beginning, middle, and end) during the course of the study and one family member turned in the family steps per day and cereal consumption data after Weeks 3 and 10. EXP and CON families were given refrigerator magnets and stickers for bathroom mirrors with written reminders to record daily steps and cereal servings consumed. All families were also provided with calculators to help them calculate weekly averages for steps per day and cereal servings per day consumed.

Methods of Assessment

All participants completed a 7-day baseline period where usual steps per day were assessed using step counters, and usual food intake was assessed using 3-day food records. Each family member also recorded the number of usual cereal servings consumed per day during this period. We also obtained heights and weights of all participating family members at the beginning of the 7-day baseline period. BMI was calculated from height and weight, and for children, percentage BMI-for-age was calculated (8). Additionally, percentage body fat estimates were calculated from skinfold thickness measurements taken using Lange calipers. For adults, measurements were taken from biceps, triceps, subscapular, and suprailliac areas, and percentage body fat was estimated (13). For children, measurements were taken at the triceps and medial calf areas, and percentage body fat was estimated (14).

Outcome Measures

Steps and cereal servings consumed were recorded daily throughout the study in the EXP and CON families. Food intake was recorded again in the middle and at the end of the study for both groups using 3-day food records. Body weight, height, and skinfold thickness measurements were assessed again at the end of the study. BMI was calculated for all participants, and percentage BMI-for-age was calculated for all children.

There is limited evidence on normal body composition among children and adolescents and lack of criterion standards for adiposity among children. Based on expert recommendations, changes in percentage BMI-for-age were used in children and adolescents to identify rate of excessive weight gain relative to linear growth as the primary body weight/adiposity outcomes measure. Although percentage BMI-for-age is a measure of relative weight rather than adiposity, it is recommended widely for use as a screening tool to determine overweight and is the currently preferred clinical measure (15). We used percentage body fat as a secondary measure for the children and adolescents. Body weight, BMI, and percentage body fat were used as primary body weight/adiposity outcome measures for the parents.

Statistical Analyses

We used ANOVA to evaluate the impact of the intervention on steps, cereal consumption, food intake, and measures of body weight and body fatness. Analyses were based on linear mixed models with random effects for subjects to account for the measurement of subjects at multiple times using SAS statistical software (SAS Institute Inc., Cary, NC). We carried out separate analyses for three groups: parents, target children ($\geq$85th percentile BMI-for-age and 8 to 12 years), and other children (all children ages 8 to 17 years who did not meet the target child criteria in each family). In each analysis, factors were included for sex (male or female), group (EXP or CON), and their interaction.

For steps, we calculated and used the average steps per day. Only daily step data recorded as $\geq$1000 and/or $\leq$30,000 steps/d was used; any step data that fell outside this range were identified as unusual and set missing for that given day.

For cereal consumption, we used the number of cereal servings consumed per day. These data were then summarized into average number of cereal servings consumed per week over the course of the 14-week study.

For dietary intake, we analyzed food records to determine total daily kilocalories, fat (grams), percent of calories from fat, carbohydrate (grams), protein (grams), fiber (grams), and calcium (milligrams). Analyses were done using Computrition Nutritional Software Library software (large database, version 3.2, MA1556; Computrition, Chatsworth, CA).

We analyzed the impact of the intervention on body weight, BMI, and percentage body fat in adults and percentage BMI-for-age and percentage body fat in children and adolescents. When designing this pilot study, we were especially interested in knowing whether families with overweight children could adapt their usual lifestyles to incorporate two small healthy behavior changes (take 2000 more steps/d and consume cereal for breakfast and a snack every day) when participating in a family-based program. Although we had previously demonstrated that adults participating in our AOM programs successfully increased their step counts over time, we had yet to test the effectiveness of

Table 1. Completion rates among groups (total participants completing study/total participants enrolled)

	EXP	CON	TOTAL
Families	62/82 = 75.6%	19/23 = 82.6%	81/105 = 77.1%
Moms	60/79 = 75.9%	18/21 = 85.7%	78/100 = 78.0%
Dads	35/46 = 76.1%	12/13 = 92.3%	47/59 = 79.7%
Target girls	29/40 = 72.5%	12/14 = 85.7%	41/54 = 75.9%
Target boys	39/53 = 73.6%	8/11 = 72.7%	47/64 = 73.4%
Other girls	16/30 = 53.3%	6/9 = 66.7%	22/39 = 56.4%
Other boys	18/22 = 81.8%	6/10 = 60.0%	24/39 = 75.0%

EXP, experimental; CON, control.

this message in children and overweight children in particular. As such, we chose to enroll more EXP families and, thus, more EXP overweight children than CON families. We realize that having unequal subject numbers in each group resulted in lower power but felt that the information gained from the EXP families would be of great value to our working knowledge of the effectiveness of our family-based intervention.

Results

Table 1 shows the makeup of the families that comprised each group and the drop-out rates for each group. The final sample included 62 EXP families and 19 CON families. The overall drop-out rate was 24% for the EXP families and 17% for CON families. Table 2 shows baseline characteristics for the parents, target children, and other children.

Although the subjects of primary interest in this study were the target overweight children and their parents, the intent of our intervention was to promote small lifestyle changes for the entire family. As such, we encouraged all family members to participate in the study. Many families did not have other children participants; as a result, subject numbers for this group are small (approximately one-half the number of target overweight children). Additionally, this group of children was much more disparate/variable with regards to age and adiposity levels than the overweight target children. The other children were older (~2 years older), included a larger age range (8 to 17 vs. 8 to 12 years) and were considerably leaner (classified as normal weight per percentage BMI-for-age criteria and had lower percentage body fat) than the overweight target children. As such, the results of the other children will be reported; however, results should be interpreted with caution.

Steps per Day

Steps per day increased in all members of the EXP families but not in any members of the CON families. Figures 1 and 2 show the average number of steps per day taken during the baseline week and during the following 13 intervention weeks (Weeks 2 to 14) for the target girls and target boys and the moms and dads, respectively. EXP target girls, target boys, moms, and dads all took significantly more steps per day on average during the intervention weeks (Weeks 2 to 14) than their CON counterparts. Additionally, steps per day increased significantly over baseline measures in each of these four EXP groups, increases that approached the primary goal of the intervention, to take an additional 2000 steps/d more than baseline levels. Similarly, both the EXP other girls and other boys increased their steps per day significantly over baseline measures; however, their steps per day taken during the 13-week intervention did not differ from the CON other girls or other boys (Figure 3). None of the CON groups (moms, dads, overweight target girls, overweight target boys, other girls, or other boys) changed their step counts over the course of the study; thus, they attained their group-specific study goal, to maintain their usual lifestyle with regards to step behaviors. When we tested to see whether the males and females in each group differed in their step behaviors, a test of interaction showed that differences between the EXP and CON groups did not differ for males and females.

Cereal Consumption

EXP families were advised to consume 2 servings/d of cereal. Although they did not reach this amount, EXP families consumed approximately 1 serving of cereal/d, double the amount of cereal consumed by CON families (Table 3).

Food Intake

The intervention did not produce any significant change in self-reported total energy intake or in intake of any macronutrient in either the EXP or CON groups. There were no significant between-group differences in the food intake measures either before or after the intervention, and there were no significant changes within-group for total kilocalo-

Table 2. Physical characteristics of participants at study onset

	Moms		Dads	
	EXP	**CON**	**EXP**	**CON**
Age (years)	40.8 ± 0.7	41.1 ± 1.5	42.1 ± 1.0	43.7 ± 2.2
Weight (kg)	74.8 ± 2.6	70.5 ± 3.0	93.7 ± 1.8	93.7 ± 0.8
BMI	27.8 ± 0.9	27.0 ± 1.5	29.7 ± 0.6	29.3 ± 0.8
Body fat (%)	37.1 ± 0.9	37.4 ± 1.2	30.1 ± 0.8	30.7 ± 1.2
	Target girls		**Target boys**	
	EXP	**CON**	**EXP**	**CON**
Age (years)	10.1 ± 0.2	9.9 ± 0.4	9.8 ± 0.2	9.9 ± 0.2
Wt (kg)	56.2 ± 3.5	47.9 ± 3.6	48.6 ± 1.6	55.6 ± 3.7
BMI (%)	93.6 ± 0.8	92.5 ± 1.1	93.5 ± 0.7	95.2 ± 0.7
Body fat (%)	38.0 ± 2.0	36.6 ± 2.3	35.8 ± 1.6	40.1 ± 3.4
	Other girls		**Other boys**	
	EXP	**CON**	**EXP**	**CON**
Age (years)	12.8 ± 0.7	11.8 ± 0.9	11.8 ± 0.4	12.0 ± 0.7
Weight (kg)	50.0 ± 5.2	43.8 ± 7.0	49.3 ± 3.3	42.0 ± 2.4
BMI (%)	52.1 ± 8.3	51.5 ± 13.1	59.7 ± 3.7	46.5 ± 12.7
Body fat (%)	28.6 ± 3.3	25.0 ± 3.1	24.8 ± 2.5	22.1 ± 2.9

Values are means ± standard error. EXP, experimental; CON, control.

ries or the percentage of total kcal from fat, protein, or carbohydrate as a consequence of the intervention.

Measures of Body Weight/Adiposity

Significant between-group differences ($p < 0.05$) were found pre- to post-study in the difference in the mean change of all of the body weight/adiposity measures of primary importance for the overweight target children (percentage BMI-for-age and percentage body fat) and their

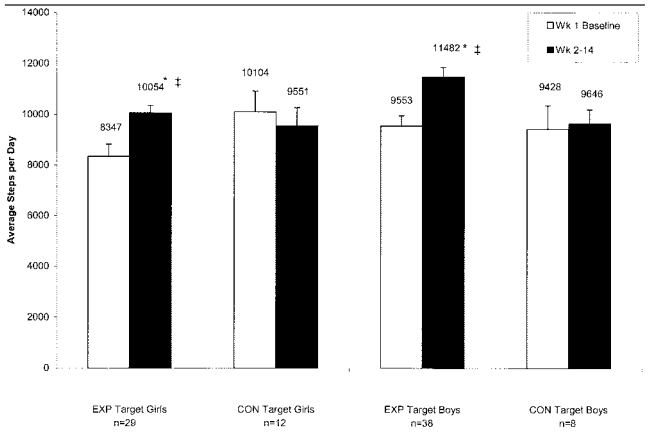

Figure 1: The average (± standard error) number of steps per day taken by the EXP and CON target girls and target boys during baseline (Week 1, white bars) and intervention weeks (Weeks 2 to 14, black bars). * $p < 0.0001$ vs. baseline. ‡ $p < 0.05$ vs. CON.

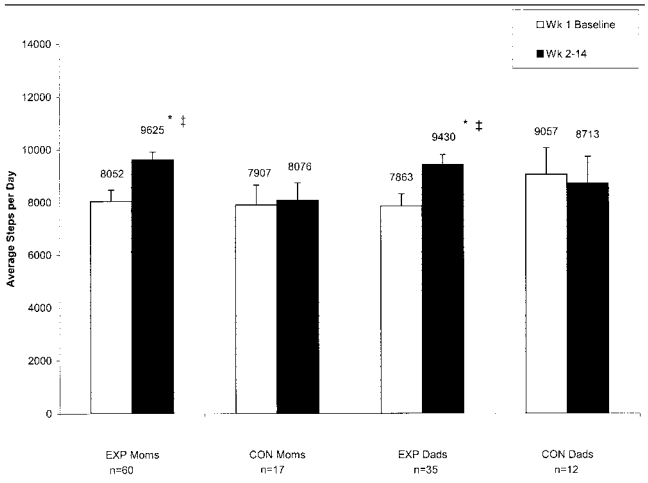

Figure 2: The average (± standard error) number of steps per day taken by the EXP and CON moms and dads during baseline (Week 1, white bars) and intervention weeks (Weeks 2 to 14, black bars). * $p < 0.0001$ vs. baseline. ‡ $p < 0.05$ vs. CON.

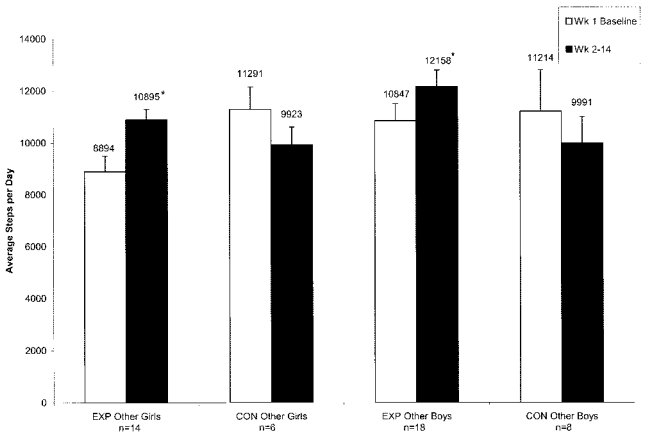

Figure 3: The average (± standard error) number of steps per day taken by the EXP and CON other girls and other boys during baseline (Week 1, white bars) and intervention weeks (Weeks 2 to 14, black bars). * $p < 0.001$ vs. baseline.

parents (weight, BMI, and percentage body fat) (Table 4). The combined trends in these measures were significant and in the expected direction (losses in both the EXP target children and their parents and gains in both the CON target children and their parents).

Based on these findings, we then decided to analyze results separately by sex, in part because of the imbalance in subject numbers between mothers and fathers (78 vs. 47). When analyzed by gender, significant between-group differences were found in the difference in the mean change of both the child- and adult-specific body weight/adiposity measures between the EXP and CON target girls and between the EXP and CON moms but not between the EXP and CON target boys nor between the EXP and CON dads.

Target Overweight Children. When combining males and females, significant between-group differences were found between the EXP and CON target children in the difference in the mean change in the two primary body weight/adiposity measures of interest for children, percentage BMI-for

Table 3. Cereal consumption

	EXP		CON	
	Servings/wk	**Servings/d**	**Servings/wk**	**Servings/d**
Parents	7.31 ± 0.04*	1.04*	3.8 ± 0.14	0.54
Target children	8.10 ± 0.17*	1.16*	3.62 ± 0.17	0.52
Other children	7.2 ± 0.07*	1.03*	4.2 ± 0.51	0.60

Values are means ± standard error. EXP, experimental; CON, control.
* $p < 0.05$ vs. CON.

Table 4 Differences in body weight/adiposity outcomes

		Mean change pre- to post-study			
		EXP	**CON**	**Diff (EXP − CON)**	***p* value**
Target Children	Weight (kg)	1.50	1.814	−0.314	0.420
	% BMI	−0.65	0.47	−1.116	0.0339
	% Body Fat	−0.51	0.91	−1.414	0.0001
Parents	Weight (kg)	−0.436	0.345	−0.782	0.0390
	% BMI	−0.15	0.13	−0.284	0.0352
	% Body Fat	−0.44	0.14	−0.58	<0.0001
Other Children	Weight (kg)	0.609	1.364	−0.750	0.239
	% BMI	−0.76	0.94	−1.69	0.0358
	% Body Fat	−1.34	2.65	−3.99	0.1657

EXP, experimental; CON, control.

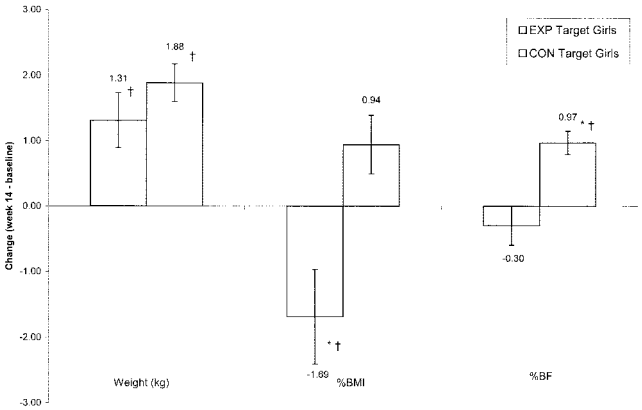

Figure 4: Changes in body weight, percentage BMI-for-age, and percentage body fat pre- to post-study in EXP ($n = 29$) and CON ($n = 12$) target girls. * Significant difference between the EXP and CON target girls in body weight measures pre- to post-study ($p < 0.05$). † Significant within-group differences pre- to post-study ($p < 0.05$).

age (−1.116%, $p = 0.0339$) and percentage body fat (−1.414%, $p = 0.0001$) (Table 4). These significant between-group findings were driven by the opposing directional trends (decreases in the EXP target children and increases in the CON target children) observed in each of these measures. When broken down by sex, between-group findings were significant for the target girls but not for the target boys on these measures.

Target Overweight Girls. Significant between-group differences were found between the EXP and CON target girls in the difference in the mean change in the two primary body weight/adiposity measures of interest for children; percentage BMI-for-age (−2.628%, $p = 0.0039$) and percentage body fat (−1.26%, $p = 0.0007$) (Figure 4). These significant between-group findings were driven by the opposing directional trends (decreases in the EXP target girls and increases in the CON target girls) observed in each of these measures. Percent BMI-for-age decreased significantly pre- to post-study in the EXP target girls (−1.69 ± 3.92%, $p = 0.0282$) and increased non-significantly in the CON target girls (0.94 ± 1.55%, $p = 0.0597$). Percentage body fat decreased non-significantly pre- to post-study in the EXP target girls (−0.30 ± 1.59%, $p = 0.3259$) and increased significantly in the CON target girls (0.97 ± 0.61%, $p = 0.00018$). Even though both the EXP and CON target girls gained significant weight over the course of the study (1.31 ± 2.30 kg, $p = 0.0047$ vs. 1.88 ± 0.99 kg, $p = 0.00004$; respectively), with the EXP target girls gaining an average of 0.57 kg less than the CON target girls, the two groups did not differ significantly in these gains. It is important to note that body weight measures in children do not take into account changes in height due to normal growth and, thus, should not be used as indicators of adiposity in children.

Target Overweight Boys. No significant between-group differences were found between the EXP and CON target boys in the difference in the mean change in the two primary body weight/adiposity measures of interest for children; percentage BMI-for-age (0.3679%, $p = 0.6016$) and percentage body fat (−1.486%, $p = 0.1073$). The EXP or CON target boys did not have significant within-group changes in percentage BMI-for-age (0.12 ± 1.85%, $p = 0.6932$; vs. −0.25 ± 1.50%, $p = 0.6524$, respectively) or percentage body fat (−0.66 ± 2.45%, $p = 0.1007$; vs. 0.83 ± 1.54%, $p = 0.1735$; respectively). Similar to the target girls, opposing directional trends (decreases in the EXP target boys and gains in the CON target boys) were found in the percentage body fat measures; however, these trends were reversed in the percentage BMI-for-age measures. Similar to the target girls, both the EXP and CON target boys gained significant weight pre- to post-study (1.63 ± 1.92 kg, $p = 0.00001$, vs. 1.70 ± 1.81 kg, $p = 0.0325$, respectively), with the EXP target boys gaining 0.70 kg less than the CON target boys. The two groups did not, however, differ significantly in these gains.

Parents. When combining males and females, significant between-group differences were found between the EXP and CON parents in the difference in the mean change in the three major body weight/adiposity measures of interest for adults; weight (−0.782 kg, $p = 0.0390$), BMI (−0.284, $p = 0.0352$), and percentage body fat (−0.583%, $p < 0.0001$) (Table 4). These significant between-group findings were driven by the opposing directional trends (decreases in the EXP parents and increases in the CON parents) observed in each of these measures. When broken down by sex, findings were significant for moms but not for dads on these measures.

Moms. Significant between-group differences were found in the difference in the mean change between the EXP and CON moms in the three major body weight/adiposity measures of interest for adults; weight (−1.04 kg, $p = 0.0271$), BMI (−0.394, $p = 0.0274$), and percentage body fat (−0.694%, $p < 0.0001$) (Figure 5). Similar to the overweight target girls, these significant between-group findings were driven by the opposing directional trends (decreases in the EXP moms and increases in the CON moms) observed in all three measures. One of these within-group changes was statistically significant. The EXP moms had a significant decrease in percentage body fat pre- to post-study (−0.49 ± 0.91%; $p = 0.00014$) compared with a non-significant increase (0.21 ± 0.38%, $p = 0.0546$) in the CON moms.

Dads. Similar to the target overweight boys, no significant between-group differences were found in the difference in the mean change between the EXP and CON dads in the three major body weight/adiposity measures of interest for adults; weight (−0.373 kg, $p = 0.6149$), BMI (−0.113, $p = 0.6352$), and percentage body fat (−0.410%, $p = 0.0887$).

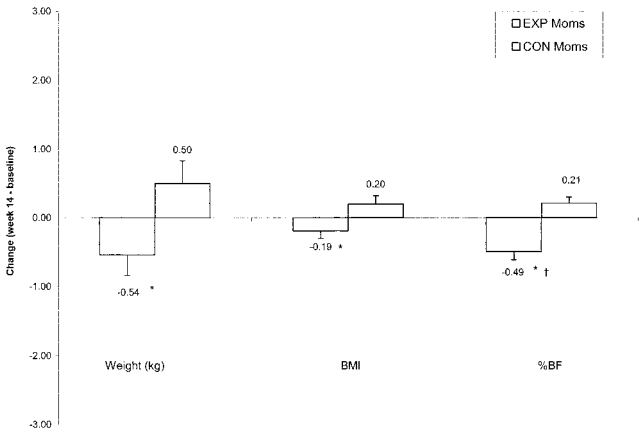

Figure 5: Changes in body weight, BMI, and percentage body fat pre- to post-study in EXP ($n = 58$) and CON ($n = 15$) moms. * Significant difference between the EXP and CON moms in body weight measures pre- to post-study ($p < 0.05$). † Significant within-group differences pre- to post-study ($p < 0.05$).

Although opposing directional trends (decreases in the EXP dads and increases in the CON dads) were observed in each of these three measures, only one of the within-group changes was statistically significant. The EXP dads exhibited a significant pre- to post-study decrease in percentage body fat ($-0.37 \pm 0.67\%$, $p = 0.0028$), whereas the CON dads exhibited no pre- to post-study change in percentage body fat ($0.04 \pm 0.59\%$, $p = 0.8241$).

Other Children. When combining males and females, significant between-group differences were found between the EXP and CON other children in the difference in the mean change in percentage BMI (-1.692%, $p = 0.0358$) (Table 4). An opposing directional trend (decrease in the EXP other children and increase in the CON other children) was also observed in percentage body fat.

Other Girls. No significant between-group differences were found between the EXP and CON other girls in the difference in the mean change in either percentage BMI-for-age (-5.56%, $p = 0.1672$) or percentage body fat (-2.672%, $p = 0.1154$). Opposing directional trends (decreases in EXP other girls and increases in CON other girls) were observed pre- to post-study in both measures ($-0.16 \pm 7.19\%$, $p = 0.936$ vs. $5.40 \pm 9.54\%$, $p = 0.2244$; and $-1.05 \pm 1.56\%$, $p = 0.0261$ vs. $1.63 \pm 3.40\%$, $p = 0.2940$ respectively) with the EXP other girls exhibiting a significant within-group decrease in percentage body fat pre- to post-study.

Non-significant within-group increases in body weight were observed pre- to post-study in both the EXP and CON other girls (0.41 ± 1.64 kg, $p = 0.3618$ vs. 1.59 ± 2.47 kg, $p = 0.1759$). Again, non-significant trends show that the EXP other girls gained less weight than the CON other girls.

Other Boys. No significant between-group differences were found between the EXP and CON other boys in the difference in the mean change in either percentage BMI-for-age (-2.158%, $p = 0.6054$) or percentage body fat (-0.7760%, $p = 0.3126$). None of the within-group findings were significant on either measure; however, directional trends (decreases in the EXP other boys and increases in the CON other boys) were again observed pre- to post-study in both percentage BMI-for-age ($-2.26 \pm 8.99\%$, $p = 0.3014$ vs. $-0.10 + 7.80\%$, $p = 0.9760$) and percentage body fat ($-0.53 + 2.67\%$, $p = 0.4100$ vs. $0.25 + 1.00\%$, $p = 0.5761$).

Non-significant within-group increases in body weight were observed pre- to post-study in both the EXP and CON other boys (0.76 ± 1.93 kg, $p = 0.1115$ vs. 1.13 ± 1.740 kg, $p = 0.1711$). Again, non-significant trends show that the EXP other boys gained less weight than the CON other boys.

Discussion

These results were supportive of our hypothesis that small lifestyle changes can be achieved through a family-based program and can have an important impact on preventing weight gain in adults and excessive weight gain in growing overweight children. This short-term study was designed largely to assess the feasibility of intervening in the family unit to achieve small lifestyle changes. That the intervention was successfully implemented and that it produced significant increases in steps and cereal consumption and significant improvements in body weight/adiposity measures over time in the target overweight children and their parents was extremely encouraging. The fact that such effects were seen over such a short intervention period (13 weeks) suggests that a family-based intervention to produce small lifestyle changes has great potential to help in prevention of obesity.

This intervention was based on our hypothesis that weight gain can be prevented with small changes in energy balance. In adults, we estimated that weight gain could be prevented in 90% of the population by changing energy balance (some combination of reducing energy intake and increasing energy expenditure) by 100 kcal/d. Some have argued that such small changes may not be effective in children (16). These results would suggest that small lifestyle changes can be effective in overweight children in reducing or preventing excessive weight gain. Certainly, additional work is required to assess the long-term impact of small lifestyle changes on the development or worsening of obesity. Some children may be at much higher risk of gaining weight, and greater lifestyle changes may be needed. However, this is a promising intervention that could have an important impact in many families with children that are overweight or at-risk of becoming overweight.

The study was not designed to separate effects of the dietary and step interventions. Families in the EXP group made significant improvements in their step counts that

contributed to them consistently taking significantly more steps per day than their CON counterparts over the course of the study. EXP families also consumed significantly more cereal than their CON counterparts (approximately 1 vs. 0.5 serving/d) over the course of the study. There was no obvious effect of the cereal intervention (the only dietary change requested of the intervention families) on overall energy intake or on intake of any macronutrient. However, self-reported energy intake is notoriously prone to error, and it is difficult to accurately assess small changes in total energy intake. Others have found that eating breakfast has a positive impact on reducing energy intake (11), maintaining a healthy body weight (12), and is a factor associated with long-term success in weight loss maintenance (10).

We do not know why there were greater effects on measures of obesity in girls and their mothers than in boys and their fathers. There was no indication that the behavior changes (i.e., walking and cereal consumption) differed between sexes. Some indicators in boys and dads were in the direction of greater effects in the EXP group, and these may have become significant with longer interventions. Alternatively, it is possible that this intervention is more effective for females than males. Participation in our family-based intervention appears to have done more than prevent excessive weight gain in the overweight target girls. The significant within-group losses in percentage BMI-for-age indicate that these growing overweight children gained less weight than that attributable to normal growth and, as such, were growing into healthier body weights over the course of the study. Given that there was no reported change in energy intake, it could be that females compensate less for small increases in physical activity than for larger ones, making the small change approach particularly useful for girls. These questions can only be answered with longer interventions.

Although subjects were asked not to change their level of physical activity during baseline, they were able to see their steps totals on their step counters, and this may have influenced baseline steps per day. In a statewide survey in Colorado, we found that the average number of steps/d by adults was ~6000 (17), and the average number taken by children between the ages of 10 and 17 was 7902 steps/d (Stroebele N, Wyatt HR, Reed GW, Peters JC, Hill JO, unpublished data). Although the step totals for the children in this study were probably influenced by the access to step counter feedback during baseline, even these values are not optimal for children of this age. Many experts feel that adults should be aiming to get at least 10,000 steps/d and that steps per day should be much higher for children.

The intervention used in the present study was developed as part of the larger national initiative, AOM. AOM is a national initiative of the AOM Foundation to prevent excessive weight gain through a small changes approach (7). A version of this family-based weight gain prevention program will soon be provided free of charge by the internet (7). Other AOM programs are currently being evaluated in worksites, schools, and communities. It is important to note that the small change approach promoted by AOM is aimed to prevent gradual weight gain produced by gradual positive energy balance. The pattern with which excessive weight gain occurs is not clear. It may be gradual and consistent or episodic. Whether or not small changes in energy balance would be cumulative and would counter larger episodic periods of positive energy balance is not clear. Although additional data are clearly needed to substantiate this approach to weight management, these results are extremely encouraging and indicate that longer studies are warranted.

In summary, we demonstrated that a family-based intervention aimed at helping children at-risk-for-overweight or overweight and their parents increase steps and consume cereal was successfully implemented over a 14-week period and had a positive impact on some indicators of obesity.

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