Small Changes in Dietary Sugar and Physical Activity as an Approach to Preventing Excessive Weight Gain: The America on the Move Family Study

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ABSTRACT

OBJECTIVES. The intent of this study was to evaluate whether small changes in diet and physical activity, as promoted by the America on the Move initiative, could prevent excessive weight gain in overweight children.

METHODS. In this family-intervention study, the America on the Move small-changes approach for weight-gain prevention was evaluated in families with at least 1 child (7–14 years old) who was overweight or at risk for overweight. These children were the primary target of the intervention, and parents were the secondary target. Families were randomly assigned to either the America on the Move group (n = 100) or the self-monitor–only group (n = 92). Families who were assigned to the America on the Move group were asked to make 2 small lifestyle changes: (1) to walk an additional 2000 steps per day above baseline as measured by pedometers and (2) to eliminate 420 kJ/day (100 kcal/day) from their typical diet by replacing dietary sugar with a noncaloric sweetener. Families who were assigned to the self-monitor group were asked to use pedometers to record physical activity but were not asked to change their diet or physical activity level.

RESULTS. During a 6-month period, both groups of children showed significant decreases in BMI for age. However, the America on the Move group compared with the self-monitor group had a significantly higher percentage of target children who maintained or reduced their BMI for age and, consistently, a significantly lower percentage who increased their BMI for age. There was no significant weight gain during the 6-month intervention in parents of either group.

CONCLUSIONS. The small-changes approach advocated by America on the Move could be useful for addressing childhood obesity by preventing excess weight gain in families.
The rapid rise in the prevalence of childhood overweight is one of the most alarming public health issues facing the world today. Recent data from the National Health and Nutrition Examination Survey estimate that 17.1% of US children are overweight (≥95th percentile for BMI for age) and that an additional 15% of children are at risk for overweight (≥85th percentile for BMI for age).

Directly associated with the rise in childhood overweight is an increase in the prevalence of weight-related medical problems, such as hypertension, type 2 diabetes, pulmonary complications (e.g., asthma, sleep apnea), abnormal growth acceleration, dyslipidemia, musculoskeletal problems, and psychosocial problems.

Childhood obesity is increasing at a higher rate than adult obesity, and the likelihood is high that most overweight children and adolescents will become overweight or obese adults.

Despite the seriousness of the problem, few strategies have been found to be effective in preventing or treating overweight in children. Several years ago, Hill et al. suggested that a strategy of preventing excessive weight gain may be more feasible than a strategy of weight reduction for the entire population. They further proposed that excessive weight gain could be prevented in most adults through a small-changes approach to diet and physical activity; specifically, a 420 kJ/day (100 kcal/day) change in any combination of increased energy expenditure and decreased energy intake. Recent data from Wang et al. found that excessive weight gain in children seems to be attributable, on average, to an extra 630 kJ/day (150 kcal/day), suggesting that small lifestyle changes can be used to prevent excessive weight gain in children and adolescents.

America on the Move (AOM) is a nonprofit initiative to inspire Americans to make small lifestyle changes to prevent excessive weight gain (www.americaonthemove.org), starting with (1) reducing energy intake by 420 kJ/day (100 kcal/day) and (2) increasing physical activity (walking) by 2000 steps per day. We have demonstrated that providing pedometers along with a message to increase steps by 2000 above baseline leads to an increase in total physical activity. Similarly, we have preliminary data to show that the message to reduce energy intake by 420 kJ/day (100 kcal/day) results in a significant decrease in total energy intake of ~1260 kJ/day (300 kcal/day).

The intent of this study was to evaluate further whether the small-changes strategy recommended by AOM could be effective in preventing excessive weight gain in families with overweight children. The importance and effectiveness of family-based childhood overweight prevention programs has been demonstrated in other studies, and experts have recommended a family-based approach as the best way to address excessive weight in children. Recently, we evaluated the small-changes approach in a family intervention in families with at least 1 child who was overweight or at risk for overweight. The intervention consisted of providing cereal for breakfast and as a snack (a dietary change thought to reduce total energy intake) and increasing physical activity by 2000 steps per day above baseline. This program successfully reduced BMI for age in overweight girls and prevented maternal weight gain during a 13-week intervention period. However, the program did not successfully prevent excessive weight gain in overweight boys or their fathers.

In this study, we again designed a family-based intervention program targeting families with at least 1 child who was overweight or at risk for overweight; however, this time, a 6-month study period was chosen to determine the effects of a longer intervention period. The intervention consisted of increasing physical activity by 2000 steps per day above baseline and reducing sugar intake by 420 kJ/day (100 kcal/day) in all family members by using a noncaloric sweetener, sucralose (Splenda; McNeil Nutritional, LLC, Fort Washington, PA), to replace sugar. Sucralose was chosen as an easy tool to use to reduce sugar intake. It is widely available in beverages and foods, and retail sucralose-based formulations (Splenda no-calorie sweetener products) that allow individualized use (packets) and use in cooking and baking (granular) exist. We delivered the intervention during a 6-month period and compared families in the AOM group with families in a control group, who were asked to self-monitor (SM) but not alter their diet or physical activity level.

**METHODS**

**Recruitment of Families**

Families with at least 1 child (7–14 years old) who was overweight or at risk for overweight were recruited from the metropolitan Denver, Colorado, area. The study was approved by the Colorado Multiple Institutional Review Board of the University of Colorado at Denver and Health Sciences Center. Written informed consent and assent were obtained from parents and children, and parental consent was obtained for all minors who participated in the study. Families were defined as 2 or more individuals who resided in the same household and who had some common emotional bond. This definition included both single-parent/guardian and 2-parent/guardian families. Children who were overweight or at risk for overweight were defined as those with a BMI ≥85th percentile (corresponding to a z score ≥1.036) for age and gender based on the 2000 Centers for Disease Control and Prevention criteria. At least 1 parent or guardian had to agree to participate in the study. Exclusion criteria for children and parents were medical or physical conditions that prevented them from engaging in physical activity, as assessed by a health history questionnaire.
that included the Physical Activity Readiness Questionnaire, and pregnancy or lactation.

Recruitment was via print materials and/or e-mails sent to schools, pediatrician offices, health organizations, and community organizations. A telephone number was provided for interested parents to obtain more information. Research staff screened 828 families via telephone and identified 298 families who qualified for the study (149 randomly assigned to AOM and 149 randomly assigned to SM). Of the 298 families who qualified and were invited to a study meeting, 216 attended. Twenty-four families (13 AOM; 11 SM) did not complete baseline measures. Main reasons for dropouts were lack of time, family issues, and loss of interest. Therefore, 100 AOM and 92 SM families began the intervention.

Study Overview
Families were asked to participate in the study for 6.5 consecutive months, which included a 2-week baseline period and a 6-month (24-week) intervention period. Families from both groups met with study staff on 6 occasions, as follows: at study enrollment (meeting 1); after the 2-week baseline period (meeting 2); and at the end of intervention weeks 6, 12, 18, and 24 (meetings 3–6). These sessions were used to assess outcome measures, collect participants’ data, answer questions, and encourage continued participation in the study. Study staff contacted each family by telephone the week before each meeting to confirm meeting dates and times.

Group Assignments and Interventions

AOM Group
Families who were randomly assigned to the AOM group were asked to make 2 small lifestyle changes.

Physical Activity Changes
All AOM families were asked to wear pedometers during the first 2 weeks of baseline measures and throughout the 6-month intervention period. After establishing an average baseline activity level (steps per day), each AOM family participant was instructed to increase his or her daily physical activity by 2000 steps per day above baseline and to maintain this goal as a daily minimum for the duration of the 6-month intervention. All AOM participants were encouraged to set individual and family-specific physical activity goals to help target children and parents attain their study goals. To encourage step goal attainment, AOM families were given a list of simple ways to increase steps (eg, park farther away, walk the family dog, use the stairs instead of the elevator or escalator); maps of local walking/biking/hiking trails, parks, and recreation areas; and a list of local fun walks/runs.

Dietary Changes
Each AOM family participant was instructed to eliminate 420 kJ/day (100 kcal/day) from his or her usual diet; replacement of dietary sugars alone or in food products with Splenda no-calorie sweetener packet or granular products or sucralose-containing beverages was emphasized. The sweetened food and beverage consumption information collected from families at baseline was used by investigators to formulate both family- and individual-specific suggestions on how to reduce 420 kJ/day (100 kcal/day) from their usual diet. For example, if a participant consumed sugar-sweetened sodas (420–714 kJ [100–170 kcal/day] per 12-oz can) on a regular basis, then replacement consumption of 1 can of sugar-sweetened soda with 1 can of sucralose-sweetened soda would reduce normal dietary sugar intake by ≥420 kJ/day (100 kcal/day). Our intent was to ensure that the sucralose-containing products replaced rather than complemented intake of sugar-containing products. To enhance dietary compliance, AOM families were also instructed on interpretation of nutrition labels for caloric content and serving sizes, as well as sugar and sugar-substitute terminology. In addition, families were educated about the variety of commercially available, sucralose-sweetened beverages and lower-sugar cereals; how to bake, cook, or prepare foods and beverages using the sucralose-containing sweeteners in packet and granular form; and how to calculate resultant caloric savings. Families were also educated on the benefits of eating breakfast, eating and preparing meals at home, and the 5-a-day campaign to increase fruit and vegetable consumption. At family meetings 2 through 6, AOM families were given supplies of sucralose-sweetened packets for individual use as well as sucralose-sweetened bulk granular for cooking and baking. Sample recipes using sucralose-containing products and a small allowance to help offset the cost of purchasing sucralose-sweetened beverages ($2.00 US per participant per intervention week) were also provided to AOM families. Sweetened (sugar and sugar substitute) food and beverage consumption practices were measured via assessment of participants’ attainment of caloric reduction goals and a “sweets survey.”

AOM families were asked to collect and submit grocery receipts for the 2 weeks before the intervention began. This information was used by study staff to provide family-specific tips for using sucralose-containing products to replace typically consumed sugar-containing products.

SM Group
All members of the SM families were informed that the study involved obtaining information regarding the usual physical activity level (steps per day) and usual sweetened (sugar and sugar substitute) food and beverage consumption practices of Colorado families and therefore were asked to maintain, monitor, and report their usual lifestyle for the duration of the study. All SM family members were asked to wear pedometers...
throughout the study and to complete a sweets survey that recorded the frequency of consumption of sweet foods at baseline and at the end of the study. Step logs were collected and examined by study staff at each subsequent family meeting (meetings 2–6). Study staff provided verbal motivation for continued participation in the study at each family meeting. The SM group received no information or education regarding physical activity or diet until the end of the study. On study completion, SM families were provided the AOM program and additional information to promote lifelong commitment to the concepts of the program.

Outcome Measures
Outcome measures were collected during the 2-week baseline period before study intervention and at various times throughout the intervention. At the study enrollment meeting, each AOM and SM family met with study investigators and was given group-specific instructions and print materials that included a binder that contained the group-specific study protocol and step logs. In addition, all families were given motivational reminders (refrigerator magnets and stickers for bathroom mirrors) to record daily steps and a calculator to determine the weekly average number of steps per day.

Body Weight and Adiposity Measures
Study staff measured height and weight for all participants at each of the 6 family meetings using a stadiometer (Invicta Plastics Ltd, Leicester, England) and a calibrated electronic scale (Take-A-Weigh electronic scale, model PS-6600; Befour Inc, Saukville, WI), respectively. BMI was calculated for all participants, and BMI-for-age z scores and corresponding percentile scores were calculated for target children.

Waist circumference and percentage of body fat were assessed by study staff for all participants before the intervention (family meeting 1) and after intervention months 3 and 6 (family meetings 4 and 6). Waist circumference was measured using a Gulick II tape measure (Country Technology, Gays Mills, WI), and percentage of body fat was assessed by bioelectrical impedance (Biodynamics BIA Analyzer, model 450; Biodynamics Corp, Seattle, WA).

Physical Activity Measures
For assessment of physical activity levels (steps per day), all AOM and SM study participants were given electronic pedometers (Accusplit AE120, San Jose, CA) and thoroughly instructed in their use. These types of pedometers seem to be feasible, reliable, and valid and are often used for research purposes. They were instructed to maintain (not change), monitor, and record their usual lifestyle with regard to physical activity (steps per day) during the 2-week baseline period. Participants were required to have recorded their steps for a minimum of 10 days during the 2-week baseline period to be considered “baseline completers”; only the data for baseline completers were used for baseline comparisons. Each family member, regardless of group assignment, was asked to record daily steps continuously throughout the first 18 weeks of the study and during the last week (week 24) of the study. During weeks 19 to 23, participants did not record steps per day, but AOM participants were instructed to adhere to their daily step goals.

Dietary Measures
Both groups were asked to complete a sweets survey during baseline and at the end of the 6-month intervention. The survey assessed participants’ consumption of sugar and noncalorically sweetened foods and beverages. During each intervention week (weeks 1–18 and 24), AOM participants recorded whether they believed that they met their study goal of eliminating 420 kJ/day (100 kcal/day) from their usual diet. When the dietary goal was attained, participants also recorded the method by which they attained their goal. Any combination of the following methods may have been used: (1) sucrose-based granular versus sugar, (2) sucrose-sweetened beverages versus sugar-sweetened beverages, (3) sucrose-based packets versus sugar, or (4) other methods such as substituting their usual cereals for lower-sugar/lower-calorie cereals.

Data Analysis
The primary end points were change in BMI for age for target children and change in BMI for parents. The primary outcome was BMI for age analyzed on the z score scale (z scores are considered more suitable for statistical analysis than the corresponding percentile scores). Secondary outcome measures included change in the following anthropometric measurements: BMI (children), weight, percentage of body fat, and waist circumference. We also dichotomized the outcome data for children into

<table>
<thead>
<tr>
<th>TABLE 1: Study Disposition</th>
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<tr>
<td><strong>Group</strong></td>
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<tr>
<td>Target children</td>
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<tr>
<td>AOM total</td>
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<tr>
<td>AOM boys</td>
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<td>AOM girls</td>
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<td>SM total</td>
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those who gained BMI for age during the 6-month intervention period (a change in BMI-for-age z score of >0) and those who maintained or reduced BMI for age during the 6-month intervention period (a change in BMI-for-age z score of ≤0). Measurements that were taken at family meeting 2 (end of the 2-week baseline period) were used as baseline values for estimating changes in weight, BMI, and BMI for age. Measurements that were taken at family meeting 1 were used as baseline values for determining the change in waist circumference and percentage of body fat because these variables were not measured at family meeting 2.

BMI-for-age z scores were calculated using the power in the Box-Cox transformation (L), median (M), and generalized coefficient of variation (S) parameters corresponding to the 2000 Centers for Disease Control and Prevention BMI for age growth charts (www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm). The L, M, and S parameters are provided by gender and month of age. Linear interpolation was used to obtain L, M, and S values for exact age (as opposed to rounding to the nearest month). The following equations were used to calculate BMI-for-age z scores:

\[
BMI\text{-for-age} \ z \ score = \frac{(BMIM/L) - 1}{L \times S}, \ L \neq 0;
\]

\[
= \frac{\ln(BMIM)}{S}, \ L = 0
\]

Data were analyzed by using SAS (SAS Institute Inc, Cary, NC). Significance tests were 2-sided with a significance level of .05. The primary end point analysis was a comparison of the change in BMI for age (target children) between the AOM and SM groups or the change in BMI (parents) from baseline to 6 months. Differences between group means were compared using independent samples t tests, and within-group changes were tested using paired t tests. Because not all participants had measurements at each time point (because of missed visits) and some participants dropped out of the study

| TABLE 2 Baseline Characteristics of Target Children |
|----------------|----------------|----------------|----------------|
| Measure        | AOM (n = 116) | SM (n = 102) | AOM — SM Difference (95% CI) | P* |
| Age, y         | 11.11 ± 2.08  | 11.28 ± 2.29 | −0.16 (−0.74 to 0.42)          | 590 |
| Male gender, % | 49.14         | 46.08         | 3.06 (−10.4 to 16.48)          | 654 |
| Race/ethnicity, % |           |               |                                |      |
| White          | 52.59         | 50.98         | 1.60 (−0.14 to 3.34)           | 455  |
| Black          | 13.79         | 18.63         | −4.84 (−9.30 to −0.38)         | 311  |
| Hispanic       | 13.79         | 12.75         | 1.04 (−0.90 to 2.98)           |      |
| Other          | 19.83         | 15.69         | 4.14 (1.32 to 6.96)            |      |
| Not reported   | 0.00          | 1.96          | 1.96 (−0.04 to 4.96)           |      |
| Body weight, kg| 58.3 ± 18.6   | 57.7 ± 19.4   | 0.65 (−4.5 to 5.8)             | 805  |
| BMI, kg/m²     | 25.40 ± 4.22  | 24.75 ± 5.04  | 0.65 (−0.62 to 1.92)           |      |
| BMI for age    |               |               |                                |      |
| z score        | 1.76 ± 0.45   | 1.68 ± 0.42   | 0.08 (−0.04 to 0.20)           | 1.74 |
| Percentile score | 96.05   | 95.39         | 0.66 (−0.09 to 0.24)           |      |
| Body fat, %    | 29.07 ± 6.64  | 27.49 ± 6.15  | 1.58 (−0.14 to 3.29)           | .073 |
| Waist circumference, cm | 82.34 ± 11.85 | 78.88 ± 13.65 | 3.46 (0.01 to 6.90)           | .047 |

Data are means ± SD. CI indicates confidence interval.

* P values were calculated by using independent samples t tests (Pearson χ² test for gender comparison).

** Percentile score derived from mean BMI-for-age z scores.

| TABLE 3 Changes in Measures of Body Composition, Waist Circumference, and BMI-for-Age z Score in Target Children and Body Composition, Waist Circumference, and BMI in Parents During the 6-Month Intervention Period |
|----------------|----------------|----------------|----------------|---------------|---|
| Parameter      | AOM            | SM             | AOM — SM Difference (95% CI) | P* |
| Target children, n | 95            | 89             |                             |     |
| Change in percentage of body fat | −0.262 ± 2.633 | −0.072 ± 2.363 | 0.190 (−0.924 to 0.545) | 611 |
| Change in waist circumference | −0.682 ± 4.385 | −0.219 ± 4.127 | −0.463 (−1.704 to 0.778) | 462 |
| Change in BMI-for-age z score | −0.066 ± 0.166 | −0.039 ± 0.169 | −0.027 (−0.075 to 0.022) | 282 |
| Parents, n     | 109            | 111            |                             |     |
| Change in percentage of body fat | −0.071 ± 2.084 | 0.242 ± 2.195 | −0.312 (−0.883 to 0.258) | 281 |
| Change in waist circumference | −0.0910 ± 2.970 | −0.059 ± 3.847 | −0.851 (−1.770 to 0.068) | .069 |
| Change in BMI   | −0.144 ± 0.952 | −0.013 ± 1.048 | −0.131 (−0.423 to 0.109) | 246 |

Data are means ± SD. CI indicates confidence interval.

* P values were calculated using independent samples t tests.
before the end of the 6-month intervention, a repeated-measures mixed model was fit to the data to estimate group means at each of the study visits. This method permits inclusion of patients with missing values at some time points; therefore, all available data for each participant were analyzed. Inferences based on mixed-model estimates of 6-month changes in the primary end points were similar to those obtained using the “complete case” analysis of participants who attended the 6-month visit. The percentages of target children who maintained or reduced BMI for age at the 6-month visit were compared between groups using Pearson $\chi^2$ tests.

RESULTS

Study Disposition
Study disposition and attrition rates for target children and parents are summarized in Table 1. Overall, the dropout rate for target children was 16%, with the rate slightly but not statistically significantly higher in AOM than in SM families. Adults had a similar overall dropout rate, but the parental dropout rate in the AOM group was twice that of the SM group. Dropout rates were very similar for boys and girls and for mothers and fathers within a randomized condition.

Target Children Outcomes

Body Weight and Adiposity
Baseline characteristics of the target children in each group are shown in Table 2. The ethnic breakdown is similar to the metropolitan Denver area except for the lower percentage of white (65% in metropolitan Denver) and Hispanic (30% in metropolitan Denver) individuals. At baseline, average waist circumference was statistically significantly higher in the AOM compared with the SM group, but there were no other significant differences between groups.

Target children in both groups gained weight during the 6-month intervention period, but the difference between groups was not statistically significant (mean ± SD: 2.3 ± 2.7 kg [AOM children] vs 2.6 ± 2.6 kg [SM children]). Target children in both groups experienced clinically meaningful and statistically significant decreases in BMI for age (Table 3). Although a greater average reduction in BMI-for-age $z$ score was observed in the AOM children compared with the SM children, the differences between groups were not statistically significant. Figure 1A shows the mean BMI-for-age $z$ scores during the 6-month period, and Fig 1B shows the mean change over time in BMI-for-age $z$ scores.

Although it seemed that both interventions (AOM and SM) were effective in reducing BMI for age, we did see some significant between-group differences. Figure 2 shows the percentage of target children in each group who either maintained or reduced BMI for age and the percentage who increased BMI for age during the 6-month period. Significantly more AOM target children maintained or reduced BMI for age compared with SM target children; likewise, significantly fewer AOM target children showed an increase in BMI for age compared with SM target children ($P < .05$).

Percentage of body fat was reduced but not significantly in target children in both groups during the
6-month intervention, with no statistically significant differences between groups (Table 3). Similarly, waist circumference was reduced but not significantly in both groups, and the change was not statistically significantly different between groups (Table 3).

Physical Activity
The mean number of steps per day did not differ significantly for AOM and SM target children at baseline (9265 ± 3002 [AOM] vs 9906 ± 3209 steps per day [SM]; \( P = .131 \)). Although AOM target children did not fully meet their step goals, they did report significantly more steps per day \( (P < .05) \) than SM target children (Fig 3). This difference was maintained throughout the study.

Sugar Intake
SM target children showed no significant changes in sugar intake between the baseline and end-of-study visits, whereas AOM children reported eating fewer sugar-sweetened desserts \( (P < .001) \) and fewer sweetened foods other than dessert \( (P < .001) \) and using less table sugar \( (P < .001) \) after the 6-month intervention.

Target children reported achieving their goal of cutting 420 kJ/day (100 kcal/day) on 78% of study days. As expected, the most frequent method of cutting 420 kJ/day (100 kcal/day) was to replace sugar with sucralose or sucralose-containing products. Sucralose-containing beverages were used on 28% of study days; granular sucralose was used on 26% of study days; and individual Splenda no-calorie sweetener packets were used on 6% of study days. Other methods of eliminating 420 kJ/day (100 kcal/day) were used on 37% of study days. Note that multiple strategies could have been used on any 1 day.

Parental Outcomes

Body Weight and Adiposity
There were no statistically significant differences between the baseline characteristics of parents in either the AOM or the SM group (Table 4). Adults in both groups showed slight but nonsignificant reductions in body weight during the 6-month intervention. Adults in the AOM group lost an average of 0.38 ± 2.6 kg, and adults in the SM group lost an average of 0.01 ± 2.9 kg. The percentage of adults who lost or maintained their weight was also not different between the 2 groups (49.5% [AOM parents] vs 47.8% [SM parents]; \( P < .79 \)). Similarly, there were no significant differences between groups in BMI change over time (Fig 4). Of note, neither group showed the expected gradual increase in weight over time that most American adults experience. Both groups reduced percentage of body fat and waist circumference, but the differences between groups were not statistically significant (Table 3).

Physical Activity
At baseline, steps per day were significantly higher for SM parents than for AOM parents (8737 ± 3660 steps per day [AOM parents] vs 7518 ± 2777 steps per day [SM parents]; \( P < .05 \)). Although AOM parents did not achieve their step goals, they did report significantly
more steps per day ($P < .05$) compared with SM parents throughout the intervention (Fig 5).

**Sugar Intake**

For SM families, there were no differences in reported consumption of sweet (sugar-containing and noncalorically sweetened) foods and beverages from baseline to end of study. The AOM families reported consuming fewer sugar-sweetened desserts ($P = .005$) and sweetened foods other than desserts ($P = .012$) and consuming less table sugar ($P < .001$). AOM parents reported achieving their goal of eliminating 420 kJ/day (100 kcal/day) from their diet on 77% of study days. The strategies for reducing 420 kJ/day (100 kcal/day) were very similar to the strategies reported by AOM target children; AOM parents reported using granular sucralose on 26% of study days, sucralose-containing beverages on 20% of study days, and individual sucralose packets on 15% of study days. Other methods were used on 42% of study days.

**DISCUSSION**

This study was designed as an evaluation of the effectiveness of the small-changes message promoted by AOM to reduce excessive weight gain in overweight children. These results show that emphasizing small changes, when provided as a family intervention, can help to reduce excessive weight gain in children who are overweight or at risk for overweight.

Our goal was not to produce weight loss in children but rather to reduce the rate of increase in body weight. Therefore, we believed that the best surrogate for excessive weight gain was BMI for age. Our goal was to prevent increases or produce decreases in BMI for age. Although both groups reported an average reduction in BMI for age during the intervention, significantly more children in the AOM group either maintained or reduced BMI for age than in the SM group, and significantly fewer children in the AOM group had an increase in BMI for age. Although the results are impressive even during the relatively short 6-month intervention period, the small-changes strategy may have an even greater impact if sustained for longer periods. The sustainability of this approach may be feasible in many families because the intervention is a simple one that can be applied to all members of a family, not just to family members who are already overweight or obese.

We previously demonstrated in adults that the message to increase physical activity by 2000 steps per day resulted in significant increases in physical activity and have preliminary data that the message to reduce energy intake by 420 kJ/day (100 kcal/day) resulted in a significant decrease in total energy intake. In a 12-week pilot study, we demonstrated that the small-changes approach, when applied in a family setting, could prevent

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**TABLE 4 Baseline Characteristics of Adults**

<table>
<thead>
<tr>
<th>Measure</th>
<th>AOM (n = 140)</th>
<th>SM (n = 122)</th>
<th>AOM − SM Difference (95% CI)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>44.00 ± 7.82</td>
<td>44.19 ± 7.17</td>
<td>−0.19 (−2.01 to 1.64)</td>
<td>.841</td>
</tr>
<tr>
<td>Male gender, %</td>
<td>28.57</td>
<td>27.87</td>
<td>0.70 (−10.3 to 11.72)</td>
<td>.900</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>87.2 ± 23.2</td>
<td>88.0 ± 20.7</td>
<td>−0.8 (−6.3 to 4.7)</td>
<td>.779</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>30.81 ± 7.80</td>
<td>31.14 ± 7.04</td>
<td>0.33 (−2.18 to 1.52)</td>
<td>.725</td>
</tr>
<tr>
<td>Body fat, %</td>
<td>31.95 ± 8.45</td>
<td>32.34 ± 7.60</td>
<td>−0.40 (−2.35 to 1.56)</td>
<td>.694</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>96.47 ± 16.99</td>
<td>95.19 ± 16.16</td>
<td>1.28 (−2.79 to 5.35)</td>
<td>.537</td>
</tr>
</tbody>
</table>

Data are means ± SD. CI indicates confidence interval.

*P* values were calculated by using independent samples t-test (Pearson χ² test for gender comparison).
excessive weight gain in girls. This study extends our previous results. As additional support for the small-changes approach, the intervention was effective despite that the average increase in daily steps was only approximately half of the goal and that dietary changes were not reported on 100% of study days. Future research should focus on better ways to promote adherence to lifestyle goals.

Pedometers seem to be effective tools for use in families to increase physical activity. Compliance for children and adults in monitoring steps per day was excellent. We have successfully used pedometers in several studies to increase physical activity. The immediate feedback provided by pedometers may contribute to increased physical activity.

The second part of the AOM message is to reduce energy intake by ~420 kJ/day (100 kcal/day). The AOM Web site (www.americaonthemove.org) provides many suggestions to reduce energy intake. In this study, our aim was specifically to reduce sugar intake, because excessive sugar intake by children has been implicated in the cause of obesity. We found that the noncaloric sweetener sucralose seems to be a very effective tool to produce small reductions in caloric intake by replacing sugar, both in adults and in children. The use of noncaloric sweeteners was also acceptable to both parents and children, as demonstrated by the results and the high level of interest of AOM families in learning about other sucralose-containing products. If reducing sugar intake is a way to help reduce the prevalence of childhood obesity, then greater use of noncaloric sweeteners to replace sugar-containing products should be explored. More dietary tools such as sucralose are needed to help reduce energy intake in the same way that tools such as pedometers are effective for increasing physical activity. Our results are consistent with a recent meta-analysis, which concluded that noncaloric sweeteners do not result in dietary compensation and can contribute to negative energy balance. It should be noted that the AOM families were provided with Splenda products, and they were also compensated for their time and effort to participate in the study. It is possible that provision of free products had an influence on its use.

It is important to emphasize that the SM group cannot be considered a nonintervention control group because self-monitoring, which increases awareness of diet and physical activity levels, may lead to behavior change. Although we were not able to demonstrate any major increase in physical activity, SM families may have altered food intake in a positive way (ie, caloric

FIGURE 5
Average steps per day for AOM and SM parents over the 6-month intervention period. Data are mean ± SE.
Therefore, our ability to demonstrate weight management program. Achieving our goal of preventing excessive weight gain would still leave most of these overweight children in the overweight category and still at increased risk for becoming overweight or obese adults and developing weight-related conditions such as diabetes or cardiovascular disease. However, in adults, the risks for developing these obesity-related diseases increase with increasing BMI. It seems logical that the same may be true in children. Therefore, preventing excessive weight gain may not be as good for overall health as losing weight and returning to the nonoverweight category, but it is better than continuing to gain excessive weight. The small-changes approach may have an even more powerful impact when delivered to children who are not yet at risk for overweight. Preventing the gradual, excessive weight gain in normal-weight children may be an effective way to reduce the prevalence of overweight in children. This was a time-limited intervention, but the small-changes approach to diet and physical activity seems to be sufficiently easy to implement that it could be sustained long-term and have an even more powerful impact on body weight. Furthermore, it is appropriate for all family members, regardless of weight status.

The parents of the children were a secondary target for the intervention. We have previously reported that the average American adult gains an average of 0.5 to 1.0 kg/year. Therefore, our ability to demonstrate weight-gain prevention during 6 months was questionable. Somewhat surprising, we saw no average weight gain in the parents during the 6-month period. Again, this may have been because of the effectiveness of self-monitoring or that the intervention may not have been of sufficient duration to demonstrate a change in adults.

CONCLUSIONS
The small-changes approach to lifestyle modification was found to be effective in helping reduce excessive weight gain in children who were overweight or at risk for overweight. In this study, pedometers and the non-nutritive sweetener sucralose were found to be useful tools to help achieve the small lifestyle changes. A small-changes approach to lifestyle modification can be easily implemented in families and could, over time, help to reduce excessive weight gain in all family members, regardless of current weight status. Additional research is needed to determine whether such a strategy may be successfully used for longer periods and whether the results of strategies that involve small lifestyle changes will be more sustainable compared with strategies that involve large lifestyle changes.

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