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Growing Healthy Families: Family Use of Pedometers to Increase Physical Activity and Slow the Rate of Obesity

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ABSTRACT

Objective: We conducted a study to determine if wearing a pedometer affects weight, body mass index (BMI), or mediators of physical activity among families.

Methods: Eighty-seven families were randomized to 1 of 3 treatments: pedometer plus education (PE), pedometer (P), or control (C). Participants in the PE and P groups wore pedometers and were encouraged to walk 10,000 steps daily for 12 weeks. PE group participants attended 6 sessions on healthy eating and exercise. Participants were surveyed about their knowledge and attitudes about healthy eating and physical activity prior to randomization, at the end of the intervention, and 9 months later. Their heights and weights were measured and BMI calculated.

Results: Children's BMI percentile decreased from baseline to end of intervention (-0.18%) and at 9-month follow-up (-0.08%) but did not differ by treatment. Children's BMI percentile varied by parental obesity status (average BMI percentile was 88.7% for children of obese parents and 78.5% for children of non-obese parents). Parents' weight decreased slightly by intervention's end (0.6 pounds) and at 9 months (1.2 pounds), but change was similar among groups. Attitudes about their physical activity level relative to their peers improved significantly among children and parents wearing the pedometer. Self-efficacy improved for parents wearing the pedometer. Both children and parents felt the pedometer increased their activity level, but most were unlikely to wear it beyond the intervention.

Conclusions: The pedometer had little impact on the activity level, weight, or BMI of participants.

INTRODUCTION

The percentage of overweight children at or above the gender- and age-specific 95th percentile of body mass index (BMI), based on height and growth charts, is increasing at an alarming rate.[1] The 1999 National Health and Nutrition Examination Survey (NHANES III) found that 14% of US 6- to 11-year-old children and 13% of 12- to 19-year-old adolescents were overweight.[2] The obesity rate for adolescents has tripled over the past 2 decades,[3] and more US adults are overweight as well. Based on 1999 NHANES III data, 34% of adults were overweight (BMI 25-29.9) and 27% were obese (BMI $\geq$30).[4]

Only half of US adolescents participate in regular, vigorous physical activity,[5-6] and 43% of all students report watching television over 2 hours per day on an average school day.[5] A 1998 survey found that 27% of US adults engaged in no physical activity, and 28% had not been regularly active in the previous week.[7]

A 2000 Report to the President from the Secretaries of Education and of Health and Human Services encourages parents to be physically active role models and to motivate their children to be active daily.[8] Parents are encouraged to set limits on sedentary activities and to plan and participate in family activities.

A pedometer is a noninvasive instrument that provides instant feedback regarding activity level by measuring vertical accelerations of the body, thus capturing a variety of activities that enhance the concept of "lifestyle activity."[9] For most adults, experts recommend

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10,000 steps, an expenditure equivalent to 150 kcal/day.[10-12] No research has been conducted among families using pedometers. We wanted to determine whether family members would wear a pedometer, if wearing the pedometer would increase family members' confidence in ability to exercise and make them more active, and whether wearing a pedometer would affect BMI.

METHODS

The Growing Healthy Families study began in September 2001 following approval from the Gundersen Lutheran Institutional Review Board. Eligible families had at least 1 child between the ages of 5 and 12 with a BMI over the 84th percentile. At least 1 adult within the family was required to participate in the study. Other siblings could participate if they wished. All participants signed consent or assent forms.

Families were randomized into 1 of 3 treatment arms: pedometer plus education (PE), pedometer (P), or control (C). PE and P group family members received a Digi-Walker pedometer (Yamax SW200; Walk4Life, Plainfield, Ill). They were instructed to wear the pedometer and walk 10,000 steps daily for 12 weeks. To measure activities that the pedometer registers poorly (e.g., swimming), families received a minutes-to-steps conversion table. To minimize variation in pedometer readings, subjects were instructed to wear the pedometer on their waistband over the center of their right thigh and to secure it with a safety strap. Families kept track of their steps and returned step logs every 2 weeks. Families were not penalized for failing to achieve the step goals.

PE group families had the same instructions as the P group but were also required to attend 6 one-hour biweekly sessions concerning nutrition, physical activity, or other parenting issues. Additionally, both the P and PE groups received a biweekly newsletter that complemented the educational theme and included fun activity tips.

All 3 groups completed pre-, post-, and 9-month follow-up surveys and had their heights and weights measured. Body mass index (BMI), calculated as a ratio of weight in kilograms to height in meters-squared, was determined for each adult. Children's BMI percentiles were determined by applying SAS macros developed by the Centers for Disease Control and Prevention. (See www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm.) Families returning for assessment at intervention's end were eligible to win a trip to Walt Disney World® (valued around $4000). Families participating in the 9-month follow-up received a $25 stipend. Control families also received a pedometer for each participating family member at this follow-up.

Surveys assessed participant exercise behaviors (e.g., frequency of active versus sedentary activities given a choice, hours spent weekly in a variety of activities, hours spent playing with their child), a normative assessment of their exercise behavior (compared with their peers), and self-efficacy to exercise. Self-efficacy measures people's confidence in their ability to be physically active in the presence of barriers. Using the self-efficacy scale developed by Marcus et al,[13] participants were asked to rate their level of confidence that they could exercise in 5 potentially undesirable situations (e.g., in bad weather).

The study was conducted in 2 sessions—1 beginning in September 2001, the other in February 2002. Two sessions were needed to manage the volume of participants. Further, 2 sessions allowed us to test "real-world conditions," when cold temperatures and snow may limit outdoor activities. Adherence to physical activity interventions was examined by calculating steps walked and percentage of days and weeks each family member reported meeting the step goals.

Survey and assessment data were maintained in locked cabinets. Data were entered into a database and analyzed using SAS statistical software.[14] Analysis of changes in weight and BMI for parents and in BMI percentiles for children—within families and across treatment—was conducted using the generalized estimating equation (GEE) approach,[15] which determined the significance of change in the weight variables by treatment, taking into account the correlation of observations within families. Additionally, analysis of variance (ANOVA) assuming no correlation between subjects was also conducted. Analysis methods used for the reported results are denoted in the tables. Categorical variables (response rates, improvement in normative attitudes) were compared across treatments at the individual level using χ^2 analyses.

RESULTS

Overall, 98 families and 353 people participated. Two families were excluded from analysis because none of the families' children had a qualifying BMI, and 9 families were excluded since most or all of the family members were missing heights or weights at both follow-up points. Analysis included 87 families and 316 people; 30 families (112 people) in the PE group, 28 families (104 people) in the P group, and 29 families (100 people) in the C group. Demographics and self-reported health conditions are shown in Table 1, with few differences

Table 1. Baseline Demographics, Health Conditions, and Treatment Compliance

Characteristic	Overall	Pedometer + Education (PE)	Pedometer (P)	Control (C)	*P*-value*
Number of Families/People	87/316	30/112	28/104	29/100	
Session 1	34/164	13/62	11/54	10/48	
Session 2	53/152	17/50	17/50	19/52	
Average Age of Child/Parent	9.7/40.5	10.1/40.5	9.4/41.0	9.6/40.1	0.4788/0.7987
% Female Child/Parent	51%/59%	48%/60%	56%/58%	50%/60%	0.7283/0.9769
Parent Marital Status (% Married)	90%	86%	88%	96%	0.2512
Child Self-Reported Conditions (%)					
Cavities	27%	26%	33%	21%	0.3542
Headaches	15%	18%	4%	23%	0.0159
Asthma	13%	16%	13%	8%	0.4785
Parent Self-Reported Conditions (%)					
Diabetes	3%	4%	0%	4%	0.3649
High Cholesterol	15%	16%	18%	10%	0.4521
High Blood Pressure	8%	6%	8%	10%	0.7948
Injuries/Joint Problems	16%	12%	20%	17%	0.5469
Headaches	16%	20%	12%	17%	0.5469
Asthma	5%	0%	8%	8%	0.1259
Completed All Assessments (%)	71%	68%	67%	79%	0.1138
Session 1/2	61%/77%	62%/72%	66%/68%	53%/90%	0.5726/0.0055
Session effect	0.0022				
% of Days Reported Met 10,000-Step Goal (Average)	48%	53%	43%	NA†	0.0122
Session 1/2	48%/48%	44%/59%	53%/37%	NA	0.1683/ 0.0001
Session effect	0.9666				
% of Weeks Reported Met 70,000-Step Goal (Average)	50%	55%	44%	NA	0.0363
Session 1/2	50%/50%	45%/62%	55%/38%	NA	0.2282/0.0001
Session effect	0.9251				

**P*-value for across treatment comparisons using analysis of variance (ANOVA) or χ^2 analyses
†NA = Not applicable

noted between groups at baseline. Most (97% of children, 99% of parents) were white.

Participation and treatment compliance is shown in Table 1. Nearly three fourths of participants completed all 3 assessments. There was no difference in participation by baseline BMI percentile for children or adults nor any other differences in demographic variables by participation status. Overall, participants reached the 10,000-step/day goal 48% of the time and achieved the 70,000-step/week goal 50% of the time. PE participants had higher compliance than P participants. Compliance by treatment was significantly better for the PE group in session 2 than for either group in session 1.

To test the effect of the pedometer on BMI change, the PE and P groups were combined. Analysis was conducted first on the child's within-family average change in BMI percentile using GEE analysis (Table 2). (The findings were similar when the analysis was conducted using ANOVA ignoring the possible family correlation.) Children's BMI percentiles did not differ significantly between PE/P and C groups at baseline, end of intervention, or at 9-month follow-up, although group C children had a slightly higher average BMI percentile at all times. Session 1 children also had a higher BMI percentile than session 2 children at all times. The GEE analysis on BMI percentile change from pre- to end of intervention indicated an average decrease in children in session 1 and 2 C groups and children in session 2 PE/P group, but an increase in the session 1 PE/P group. There was also a significant decrease in the session 1

Table 2. Body Mass Index Measures Child and Parent

	Overall	Pedometer(PE/P)	Control	*P*-value*†
Child				
Average BMI Percentile at Baseline	82.2	80.8	85.6	0.1522*
Session 1/2	87.8/79.1	86.8/77.0	91.0/83.4	0.0048*
Session Effect	0.0030a			
Average BMI Percentile at 3 Months	83.1	82.3	85.0	0.4190*
Session 1/2	88.6/79.6	88.6/77.4	88.6/83.7	0.0055*
Session Effect	0.0015a			
Average BMI Percentile at 9 Months	82.0	80.9	84.3	0.3255*
Session 1/2	86.2/80.2	88.0/77.4	81.3/85.3	0.1262*
Session Effect	0.0906a			
Change in BMI Percentile Baseline to 3 Months‡	-0.18	+0.09	-1.04	0.1143†
Session 1/2	+0.65/-0.50	+0.92/-0.51	-0.38/-1.27	
Change in BMI Percentile Baseline to 9 months‡	-0.08	+0.31	-1.32	0.2823†
Session 1/2	-1.77/+0.40	+0.70/+0.21	-7.41/+0.83	
Parent				
Average Parent Weight (Lbs) at Baseline	206.3	204.2	210.3	0.4831
Average Parent BMI at Baseline	32.0	32.0	31.9	0.9098
Session 1/2	34.6/30.5	34.6/30.3	34.6/30.8	0.8131
Session Effect	0.0004			
Weight Change Baseline to End of Intervention (Lbs)§	-0.57	-0.95	+0.19	0.2078
Session 1/2	+0.98/-1.51	+1.43/-2.77	-0.48/+0.43	0.2576/0.0015
Session Effect	0.0040			
Weight Change Baseline to 9 months (Lbs)§	-1.19	-1.74	-0.28	0.4410
Session 1/2	-0.65/-1.40	+0.60/-2.84	-3.66/+0.69	0.2334/0.1182
Session Effect	0.7132			

**P*-value for across treatment/sessions comparisons using analysis of variance (ANOVA).
†*P*-value for across treatment comparisons using generalized estimating equation (GEE) analysis.
‡A negative BMI percentile change indicates a loss in weight relative to height (desirable). A positive BMI percentile change indicates a gain in weight relative to height (undesirable).
§A negative weight change indicates a loss in weight (desirable).

group C children's BMI percentile at 9-month follow-up compared with small BMI percentile increases at the 9-month follow-up for all session 2 children and in session 1 PE/P children. The BMI percentile increases from baseline to 9-month follow-up in the latter groups were not significant.

At baseline, the average BMI percentile among children with a non-obese parent was significantly different from that of children with an obese parent—78.5% compared with 88.7%, respectively (P=0.0013). This pattern was consistent within treatment groups and at each follow-up. There was no difference in the treatment effect among children of obese or non-obese parents (Figure 1).

Overall, 26% of parents were considered severely obese (BMI ≥35), and 53% were obese (BMI ≥30) or severely obese. The BMI distribution did not differ by treatment group; however, session 1 parents were more likely to be obese than session 2 parents (P=0.0004). Average weight loss for parents from pre- to post- was 0.57 pounds (Table 2). Session 1 parents gained weight (0.98 pounds), while session 2 parents lost weight (1.51 pounds, P=0.0040). There was no difference in BMI from baseline to end of intervention by treatment. Average weight loss from pre- to 9-month follow-up was 1.19 pounds. Weight change was no longer different by session or by treatment within session. No significant difference in BMI by treatment was found, overall or within sessions. Results of this analysis did not vary when conducting the analysis using ANOVA on individual data (uncorrelated), ANOVA on the average within a couple, or when using GEE analysis.

Change in weight and BMI did not differ by sex, marital status, or baseline obesity status, but did vary by parent age. Parents 35 years or younger (n=17) lost 5 pounds from pre- to post-intervention and 10 pounds by 9-month follow-up, while older parents exhibited no change, regardless of treatment (P-values <0.05). There was no significant interaction between age and treatment, thus the younger parent controls were as likely to

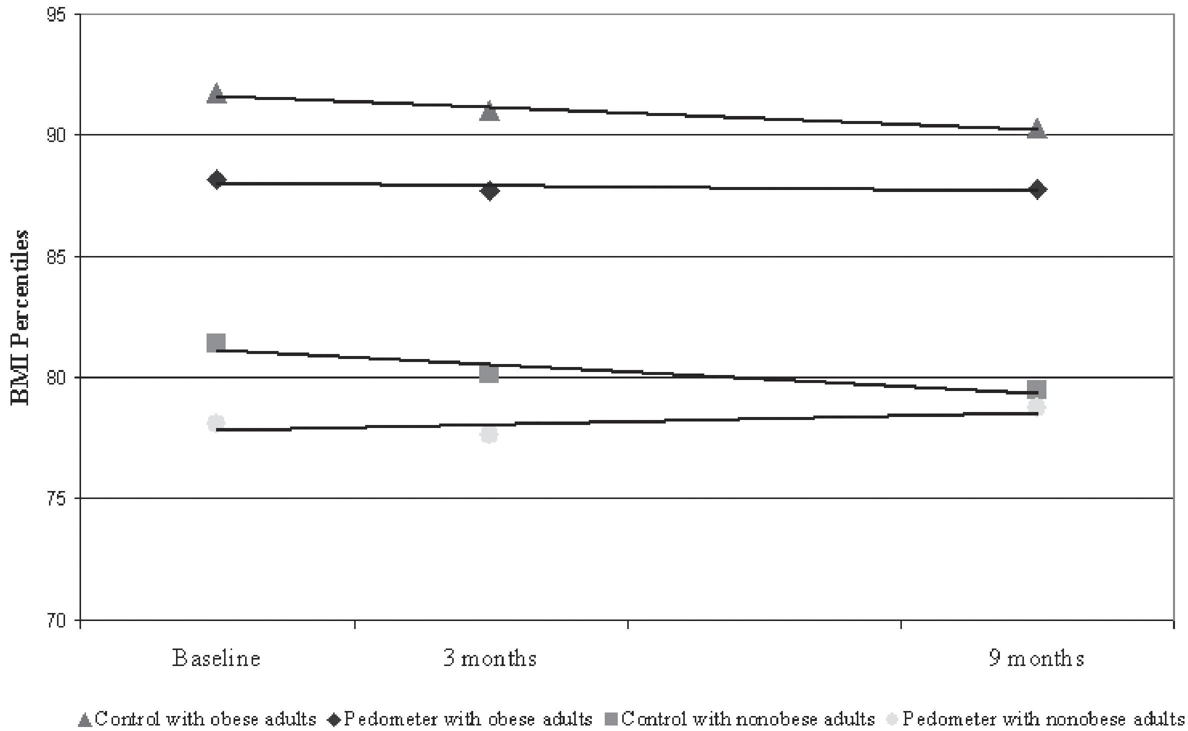

Figure 1. BMI percentile by treatment and parent obesity status.

lose weight as the younger parents wearing the pedometer. Current smokers were more likely to decrease their BMI at post-intervention and 9 months (-0.50 vs +0.04 at post-intervention, and –1.02 vs +0.01 at 9-months; *P*-values <0.05). Smokers in both PE/P and C groups were more likely to decrease their BMI compared with non-smokers. There were no differences in change in weight or BMI for children or parents by the various measures of treatment compliance. There was also no difference in change in weight or BMI from baseline to 9-month follow-up for children or parents by the amount the participant indicated wearing the pedometer from post-program to 9-month follow-up.

Potentially mediating variables such as changes in normative assessment of physical activity, self-efficacy, percent of time spent playing with children, and percent of hours spent in sedentary activity were compared across treatment (Table 3). Since these issues were addressed during education sessions, the PE and P groups were analyzed separately. Children and parents in the PE group reported significant improvements in their assessment of their exercise compared with the P and C groups at post-intervention; the difference was not significant by 9-month follow-up. Self-efficacy significantly improved by treatment among parents at both post-program and 9-month follow-up, but self-efficacy did not change by treatment for children. Overall, 15% of parents reported spending more time each week playing with their child at post-program, while 10% did so at 9-month follow-up. This did not differ by treatment. Finally, change in percent of hours each week spent in sedentary activity (e.g., television viewing, expressed as a percent based on all activities reported each week) did not differ by treatment for parents at either follow-up and differed for children from baseline to post-program only (*P*=0.0162). Sedentary activity increased for PE children at post-program, while it decreased for P and C children. No differences in sedentary activity changes were noted by session.

Finally, 68% of children reported at post-program that the pedometer made them more active and 49% enjoyed wearing the pedometer "very much." Yet only 8% of children wore the pedometer all the time from post-intervention to 9-month follow-up, and 52% of P and PE children did not wear the pedometer at all. While 91% of parents indicated at post-program the pedometer made them more active and 91% indicated they enjoyed wearing the pedometer "very much," only 11% wore the pedometer all the time from post-program to 9-month follow-up, and 35% never wore it after the intervention.

Table 3. Changes in Mediating Variables and Attitudes

	Overall	Pedometer + Education (PE)	Pedometer (P)	Control (C)	*P*-value*
Change in Normative Attitudes About Exercise Behavior (% Improved)					
Pre- to post-program					
Children	37%	48%	32%	26%	0.0475
Parent	36%	46%	41%	21%	0.0326
Pre- to 9-month follow-up					
Children	39%	50%	32%	34%	0.1462
Parent	39%	36%	44%	26%	0.7054
Change in Self-Efficacy†					
Pre- to post-program					
Children	1.18	1.27	1.47	0.74	0.8684
Parent	-0.18	1.45	0.67	-2.55	0.0028
Pre- to 9-month follow-up					
Children	1.51	2.65	0.86	0.80	0.4081
Parent	-0.16	0.85	0.88	-2.00	0.0437
Amount of Time Playing with Children Each Week (% Improved)					
Pre- to post-program	15%	17%	13%	14%	0.6476
Pre- to 9-month follow-up	10%	10%	10%	9%	0.9124
Change in Percent of Hours/Week in Sedentary Activity‡					
Pre- to post-program					
Children	-3.9%	+2.7%	-6.8%	-10.1%	0.0162
Parent	-1.6%	-5.8%	-4.0%	+4.9%	0.1023
Pre- to 9-month follow-up					
Children	-5.0%	-4.1%	-2.2%	-8.2%	0.4409
Parent	+0.03%	-1.2%	-2.3%	+3.0%	0.5445

**P*-value for across treatment comparisons using ANOVA or $\chi 2$ analyses.
†A negative change indicates a decrease in self-efficacy (undesirable).
‡A negative change indicates a decrease in percent of time/week spent in sedentary activity (desirable).

DISCUSSION

The International Consensus Conference on Physical Activity Guidelines for Adolescents recommends that adolescents be physically active daily as part of play, games, sports, work, transportation, and recreation in context of family, school, and community activities.[16] Rowlands et al[17] found the pedometer to be an objective assessment of activity in children. Researchers studying kindergarten children's pedometer use found pedometer readings correlated well with the frequency of running activity, showing a significant difference between the most and least active children according to observations and self-report.[18]

This study was designed to examine the effect of wearing pedometers on the attitudes (including self-efficacy) and behavior of participating families. We felt the pedometer would be a novel way to increase awareness of one's daily activity level without prescribing or restricting the type of activity. We hypothesized that wearing the pedometer would lead to changes in attitude and behavior that, in turn, would result in significant changes in weight and BMI.

Unfortunately, the weight and BMI changes seen in children and parents were not statistically significant by treatment group, perhaps due to weight loss seen in the control group or to the unexpected and significant differences found between sessions. Differences in change in weight or BMI by session were not likely attributable to season but, rather, to differences in family characteristics between the 2 sessions, since BMI and BMI percentile varied significantly at baseline. Likewise, the percentage of time spent in sedentary activities did not vary by session, suggesting the differences were not likely weather-related. Perhaps intervention needed to be longer to affect body composition or greater emphasis was needed on achieving the step goal. Only half the participants met the step goal, suggesting that incentives should be withheld if goals are not met. The consequence of this, however, likely would be an increase in the number of families submitting false reports in order to qualify for an incentive.

Whether 10,000 steps is a sufficient recommendation for children has not been determined. There is much debate about the 10,000-step goal overall and whether it reflects the recommendations of the Surgeon General.[19] In our study, compliance to the step protocol may have been higher in the PE group than the P group owing to the additional contact families received by coming to the biweekly classes. Overall, however, only about half of participants met the step goals.

That this study did not show significant improvements in weight or BMI does not mean that family-level interventions are ineffective. This study perhaps suffered from low power. Conducting family-level interventions adds a complexity to the analysis owing to a significant correlation between child and parent weight and weight loss patterns. Our results and conclusions did not vary based on whether the analysis considered or ignored the correlation, but perhaps we studied too few families. Additionally, differences between families at the 2 sessions cannot be further investigated without additional power. Future studies should ensure sufficient sample size and treatment intensity.

The pedometer's primary benefit may be its ability to provide immediate feedback, which may be important as a behavior modification tool. Programs that enhance one's beliefs in their ability to exercise may increase motivation to be physically active. Self-efficacy improved for parents, but this study failed to demonstrate a concomitant improvement for children. The tool used to measure self-efficacy has been validated for adults, but perhaps it is not valid for children.[13] That children and parents reported significant improvements in their exercise level relative to their peers at post-intervention is encouraging, but that most abandoned the pedometer following intervention is discouraging and suggests the difficulty we face in treating the obesity epidemic: even when effective treatments are available, getting people to use them presents a challenge.

Pedometers are no magic bullet. Treating obesity is complicated and requires a multidimensional approach. Ensuring that family members are active for at least 30 minutes daily and encouraging families to adapt activities to children's ages are important components of the approach.

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