

Effects of Group- and Individual-Based Step Goals on Children's Physical Activity Levels in School

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This study examined the effect of a 6-week school-based pedometer intervention for children. It compared the number of step counts between group- and individual-based step goal conditions over time, and compared the number of goal attainments between the two step goal conditions by physical activity levels. Ninety-nine 4th-grade students' (50 boys, 49 girls) data were analyzed. Overall step counts continued to increase over time, increasing about 19% from baseline. Different step goal conditions produced similar effects on children's physical activity levels across all time points. The number of goal attainments was higher for low active children with individual-based step goals than those with group-based step goals. Using pedometers in school is promising for enhancing physical activity in children.

Participation in physical activity during childhood has numerous benefits. Regular physical activity in children provides important protection from developing chronic diseases such as hypertension, cancer, Type II diabetes, cardiovascular disease, and obesity. Physical activity during childhood may also increase mental health by relieving the symptoms of depression and anxiety and by improving self-esteem, self-perception of competence, and body image (7,21). Because physical activity patterns are often established early in life, it is important to promote regular physical activities to young people.

A pedometer, an objective measure of step counts, has been used to assess individuals' physical activity levels and to motivate individuals to increase their ambulatory physical activity (23,24). Lately, several pedometer-based physical activity intervention studies for children have shown that such interventions increase children's physical activity levels (3,8,10,14,20). Relatively few researchers, however, have examined pedometer-based interventions for children in school settings (13,17). School-based interventions using pedometers may have great potential for increasing physical activity levels for children.

It is well documented that promoting physical activity using simple, attainable behavioral strategies (such as self-monitoring, goal setting, and feedback) is effective for interventions (12). Pedometers have been shown to assist in goal setting

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and to increase motivation in physical activity interventions (4,9). Programs using a universal (group-based) step goal (e.g., a daily steps total of “10,000”) and an individual-based step goal (e.g., self-directed, 5%, and 10% increase from baseline) have been promoted (5,6), yet there is little scientific evidence to support which step goal program is more effective for children. Thus, research examining the relationship between group-based step goal and individual-based step goal conditions is necessary.

The overall purpose of this study was to examine the effect of a 6-week school-based pedometer intervention on children’s physical activity levels, measured by step counts. Two specific objectives were to (a) compare the number of step counts between children who participated in a group-based step goal condition and children who participated in an individual-based step goal condition across all time levels, and (b) compare the number of goal attainments between two step goal conditions by physical activity levels.

Method

Participants/Data Collection

A total of 109 fourth-grade students (56 boys, 53 girls) were recruited from two schools in a medium-sized southern U.S. city. Informed-consent forms were sent to parents of all children, and children who returned affirmative parental consent and who provided their verbal assent were allowed to participate. The university Institutional Review Board approved all procedures before any data were collected.

The study intervention consisted of two phases: a 2-week baseline and a 6-week school-based pedometer intervention. During the intervention period, one school had two physical education classes (30 min each) over the entire week, while another school had only one (50-min) physical education class. For counterbalancing purposes, two classes from each school were randomly assigned to one of two groups: (a) a class receiving individual-based step goals, and (b) a class receiving group-based step goals. Individual-based step goals for each 2-week period were created by increasing the participants’ individual average number of steps taken from the previous two-week period by 5%. Group-based goals for each 2-week period were created by increasing the entire class’s average from the previous 2-week period by 5%. This sequence was repeated for the 3 two-week testing periods (i.e., every 2 weeks the step goal increased by 5%). Based on previous studies (5,6), step goals are often set by a 5–10% increase from the baseline steps. Considering that the intervention took place during a structured school day only, an increase of 5% as the goal was selected.

Before the 2-week baseline testing period, research assistants distributed the pedometers to the participants, demonstrated how the pedometers work, and gave the participants feedback on setting and attaching them. Students attached their pedometers every morning when they came into school, recorded their step counts before they went home, and left the pedometer in the class (i.e., no pedometers went home). Children’s step counts were measured with Yamax Digi-Walker SW-200 pedometers (Yamax Corp., Tokyo, Japan). The previous

literature supports the selected pedometer as a valid and reliable measure of physical activity for children (1,2).

During the 6-week monitoring program, students recorded their in-school step counts from the beginning of the school day until the end of the school day. Students recorded their step counts on individualized data sheets that specified their step goals. Students also indicated on their sheets (by circling “Yes” or “No”) whether they attained their step goal for that day. At the end of each day, teachers read the pedometer and checked that the students wrote their step counts down correctly. On the Friday afternoon of each 2-week period, research assistants collected the data sheets from all classes for that period. New goals were then calculated and on the following Monday, research assistants returned to the classes and distributed the data sheets with new step goals.

At the start of the intervention, teachers were encouraged to implement changes in their classes that would increase their students’ daily steps, at their own discretion and within the constraints of their existing schedules and routines. Each teacher developed her own changes and implemented these consistently during the 6 weeks. Examples of changes developed by the teachers included having their classes take longer routes to the cafeteria or library, taking walks around the school’s campus, and having students increase their steps while engaging in regular classroom activities (such as walking in place when papers were handed out). The teachers also wore pedometers during the school day. In addition, we provided all teachers with a classroom poster with each student’s name for purposes of public monitoring and feedback during each 2-week period. Students who reached their step goal for the day received a sticker to place on the poster for that day. Students also received a sticker for having their teacher check their daily steps count. At the end of each 2-week period, sheets were collected by research assistants and new 2-week sheets were attached to the posters.

Data Screening

Data screening and analyses were conducted using Microsoft Excel and SPSS version 15.0 (SPSS, Inc., Chicago, IL). Frequencies were run initially on all data to screen for data errors or outliers. Specifically, any in-school step counts below 500 and above 15,000 were deleted and treated as missing values. Rowe and his colleagues (16) developed practical criteria for identifying outliers in children’s daily step counts, namely fewer than 1,000 and more than 30,000 step counts. These lower and upper cut-off points, however, were not appropriate for the current study because the data were only collected in the school setting while the data in the Rowe et al. study were collected during the whole day. Considering that in-school step counts (fewer than 5,000 steps per day (1)) were about a half of the whole-day step counts (more than 11,000 steps per day (25)), daily step counts below 500 and above 15,000 steps were chosen as the criteria for eliminating outliers. One hundred twelve (2.5%) out of 4,360 data points (i.e., 109 participants \times 40 days) were eliminated due to the selected criteria.

Before replacing step counts missing data, each child’s data with missing values were further screened and only the students who had at least 50% of data (i.e., at least 5 weekdays for each 2-week period) were kept. This exclusion criterion was developed based on previous literature suggesting that a large amount of

missing data may reduce the accuracy of recovery (15,22). The mean imputation method based on an individual information-centered approach, proposed by Kang, Zhu, Tudor-Locke, and Ainsworth (11), was employed to replace the step counts missing data. Kang et al. showed that replacing missing values with the mean of remaining days of the participant was better in recovering step counts missing data compared with the traditional group average approach. Throughout the data screening, 10 children with less than 50% of complete data on any of the 2-week periods were removed. Missing values (about 19%; 780 data points out of 3960) were replaced by the average of remaining days of the participant, leaving a total of 99 children with complete data (50 boys, 49 girls).

Data Analyses

Descriptive statistics were computed for all variables. To answer the research questions, a two-factor repeated-measures ANOVA was performed. The between-subject factor was step goal condition (2 levels; group-based vs. individual-based), and the within-subject factor was time (4 levels; at baseline, 2-, 4-, and 6-week). This analysis, with step counts as the dependent variable, was chosen to compare step counts between the two goal setting conditions across all levels of the time variable (by looking at the interaction effects between goal setting groups and time factors) and to identify the difference in step counts over time (by looking at the time factor) and between goal-setting condition (by looking at the step goal condition factor).

This study also compared the number of goal attainments between step goal conditions by physical activity levels of children. A 2×3 (step goal conditions \times physical activity level) ANOVA was performed. The measurement of goal attainments reflected the number of days children met their individual- or group-based step goal. Based on the 6-week intervention, a maximum number of 30 (6-week \times 5 weekdays) goal attainments was possible. Children's physical activity levels were classified as low ($< 4,800$), medium, and high ($> 6,300$) step counts based on 33 and 67 percentiles from the baseline average step counts. A significance level was set at .05 a priori.

Results

The mean, standard deviation, and minimum and maximum values of the step count data ($n = 99$) are presented by day in Table 1. The highest mean step counts were found on Thursdays (Mean \pm SD: 6,025 \pm 2,246), and the mean step counts on Mondays were reported as the lowest (5,504 \pm 2,063). Children in School 2 (who had two PE classes per week) had higher average step counts (6,437 \pm 2,170) than those in School 1 (5,225 \pm 2,051). The total mean step counts were 5,837, and the minimum and maximum step counts were 506 and 14,822, respectively.

A two-factor (2×4) repeated-measures ANOVA was performed. Mauchly's sphericity test indicated that the data violated the assumption of sphericity ($\chi^2(5) = 60.227, p < .001$), so the F value was corrected using the Greenhouse-Geisser estimate. The examination of the interaction between goal setting groups and

Table 1 Summary of Step-Count Information

| | n | Mean | SD | Min | Max |
|----------|----------|-------------|-----------|------------|------------|
| School 1 | 49 | 5,225 | 2,051 | 554 | 14,159 |
| School 2 | 50 | 6,437 | 2,170 | 506 | 14,822 |
| Total | 99 | 5,837 | 2,220 | 506 | 14,822 |

Note. School 1 = One physical education class over the entire week; School 2 = Two physical education classes over the entire week.

Table 2 Mean, Standard Deviations, and Repeated Measures ANOVA Results by Goal Setting and Time

| Intervention Time | Group-based goal (n = 57) | | Individual-based goal (n = 42) | | ANOVA F | | |
|--------------------------|----------------------------------|-----------|---------------------------------------|-----------|-------------------------|-----------------|--------------|
| | Mean | SD | Mean | SD | Goal setting (G) | Time (T) | G x T |
| Baseline | 5,408 | 1,331 | 5,517 | 1,573 | .626 | 11.489* | .180 |
| at 2-week | 5,562 | 1,731 | 5,757 | 1,413 | | | |
| at 4-week | 5,616 | 1,255 | 5,984 | 2,150 | | | |
| at 6-week | 6,409 | 1,776 | 6,571 | 2,398 | | | |

* $p < .001$.

time factors revealed that there was no significant interaction effect, $F(2.10, 203.36) = .180, p = .845$. The difference in step counts between the step goal conditions was similar at each time point (see Table 2). Because of the nonsignificant interaction effect, the main effects were subsequently tested. The examination of the time factor revealed that there was a statistically significant mean difference in step counts over time, $F(2.10, 203.36) = 11.489, p < .001$. The significant main effect for time was further analyzed by “repeated” contrasts. The contrasts indicated that there was a significant increase in step counts from 4-week ($5,772 \pm 1,693$) to 6-week ($6,478 \pm 2,053$), $F(1, 97) = 30.06, p < .001$ (see Figure 1). There was no change from the baseline to 2-week, nor from 2-week to 4-week. There was no statistically significant main effect for step goal conditions.

A 2×3 (step goal conditions \times physical activity level) ANOVA showed that there was a significant step goal conditions \times physical activity level interaction on the number of goal attainments, $F(2, 93) = 10.25, p < .001$ (see Figure 2). Simple effects analyses were done to determine at which level the difference occurred, and a significant difference was found between step goal conditions at low physical activity, $F(1, 93) = 23.39, p < .001$. For the least active children, the number of goal attainments was higher for those with individual-based step goals (16.4 ± 3.1) than those with group-based step goals (6.2 ± 4.9).

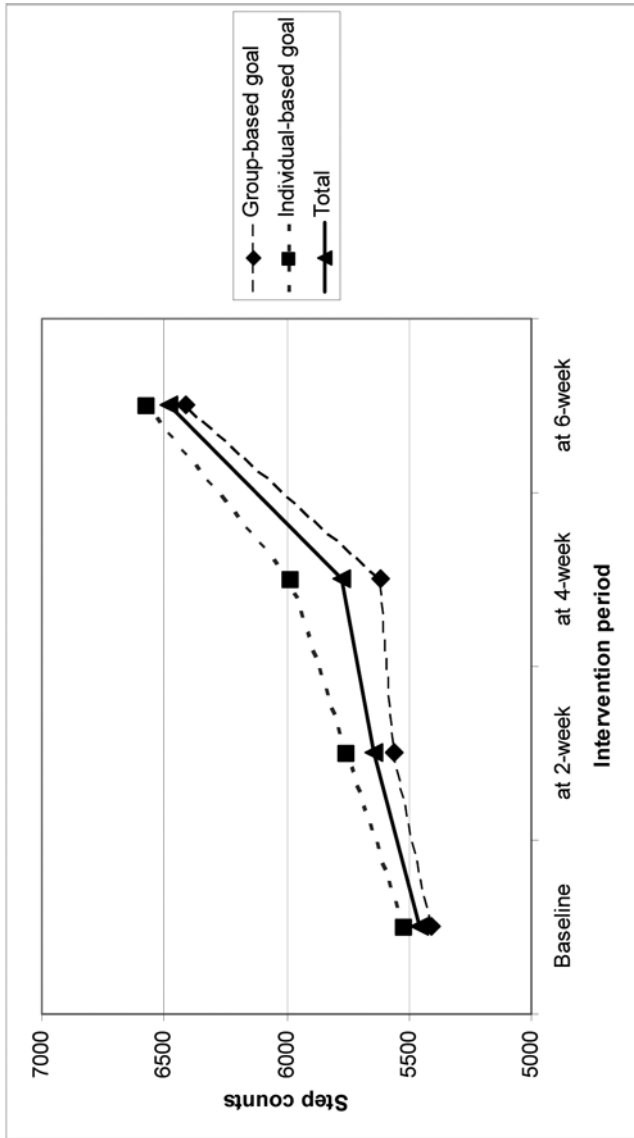


Figure 1 — Average step counts during the intervention between two goal conditions.

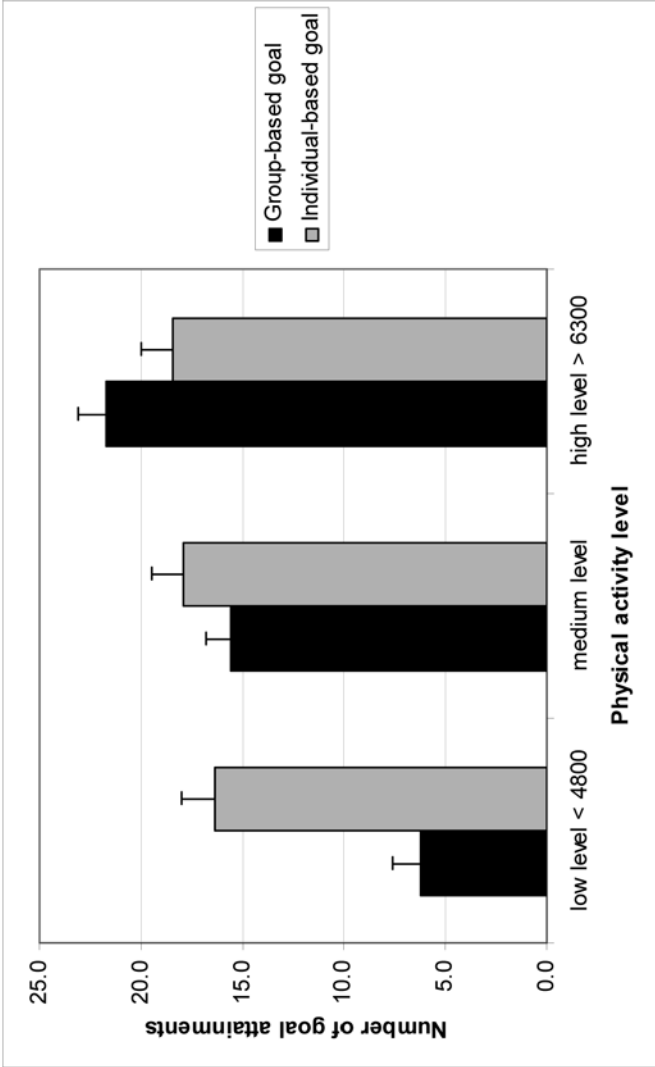


Figure 2 — Number of goal attainments between goal setting conditions by physical activity level ($p < .001$).

Discussion

This study was designed to examine the effect of a school-based pedometer intervention on children's physical activity levels. Due to the 6-week school-based pedometer intervention, children's average step counts increased about 19% from the baseline ($5,454 \pm 1,432$) to the postintervention ($6,478 \pm 2,053$; see Figure 1). This finding is comparable to previous pedometer-based intervention studies. Oliver et al. (13) designed a 4-week elementary level integrated curriculum unit, based around pedometer walking, and showed that children increased their steps about 3% from 16,305 ($SD = 5,936$) to 16,791 (4,234) in weekdays (both inside and outside of school). In that study, the increases in step counts were greatest for the children with low physical activity levels (i.e., low = < 25th percentile); percent changes from baseline to post intervention were about 50%. The study results by Schofield et al. (17) also supported our findings. In their study, a pedometer-based intervention was compared with traditional time-based physical activity prescriptions targeting low-active adolescent girls. The pedometer-based intervention group increased step counts from a baseline of 7,501 to a 6-week post intervention of 10,248, which reflected a 37% increase in step counts. These findings imply that the use of pedometers with goal-setting may enhance children's physical activity levels.

The examination of the average step counts of children between the step goal conditions over the 6-week intervention period revealed that there was no statistically significant interaction effect between step goal conditions and time. A nonsignificant interaction, in combination with a nonsignificant main effect for step goal conditions, indicated that the step goal conditions had similar effects across all time points. This finding is similar to Sidman et al. (18), who compared step counts between a universal goal of 10,000 steps per day and personalized step goal groups for sedentary adult women and found no significant difference in step counts between the groups at baseline and post intervention. However, the group-goal used in the current study (class mean + 5%) is not what is typically thought of as a universal step goal. In addition, because of the way this goal was calculated, some of the very active students had group goals that were set below their baseline step levels. Despite these differences, similar effects from both kinds of goals were found in each study.

Previous studies indicated that a universal step goal may be inappropriate for different physical activity levels of individuals, especially for the individuals reporting either very low or very high step counts (18,19). The results that compared the number of goal attainments between step goal conditions by physical activity levels of children showed that, for low physically active children, the number of goal attainments was higher for those with individual-based step goals (16.4 ± 3.1) than those with group-based step goals (6.2 ± 4.9 ; see Figure 2). The number of goal attainments between individual- and group-based goal conditions for the middle and high physically activity groups did not differ significantly. Another interpretation for the observed interaction is that individual-based goal setting was equally effective regardless of children's baseline activity levels. However, group-based goal setting was more effective for the most active kids compared with the least active. Of course, this likely reflects the fact that it was easier for the more-active kids to reach the group-based goals and harder for the less-active kids to reach those goals.

Interestingly, the goal attainment results did not correspond to a difference in average step counts from children with low physical activity between the two goal conditions, $F(1, 93) = 2.44, p = .12$. In other words, having less frequent step goal daily “successes” did not mean that these students ended up decreasing their participation in the steps program. Children with low physical activity who participated in a group-based step goal condition were actually slightly higher in step counts ($5,467 \pm 1,029$) than children who participated in an individual-based step goal condition ($4,494 \pm 1,403$) at post intervention. This implies that a lower number of goal attainments did not result in lower average step counts and, as stated by Sidman et al. (18), baseline step counts might be a more important contributor to goal attainment than step goal conditions. Future studies examining the effect of goal attainment on physical activity level are needed.

One limitation of this study is that it was not possible to identify whether children’s physical activity levels have been sustained following the completion of this study. Although the teachers and students kept the pedometers at the end of the study, it is not known whether they continued to use them for the remainder of the school year. On the positive side, both teachers and students reported that they enjoyed wearing the pedometers and keeping track of daily step counts. It is also possible that increases in step counts will reach a plateau after a certain amount of time. It is unrealistic to expect that students would continue to increase their steps after the intervention ended. If there is a ceiling effect of the intervention, the question then shifts to how can students best maintain their highest level of steps. This question was not addressed in the study. Clearly, maintenance of improved levels of physical activity is an important issue in the school setting.

Another limitation of the study is that it was not possible to determine what specific factors were most responsible for the students’ increases in step counts. Although the different goal conditions may well have encouraged the students to improve their physical activity levels, it is also possible that the teachers (both classroom and PE) played an important role in increasing student steps. Given the highly structured nature of the school day for students, as well as the absence of substantial discretionary time for increasing steps, simply providing step goals to students is unlikely to be sufficient for changes in behavior. Additional research could determine better the roles of student motivation and teacher influence in affecting physical activity levels. For example, assessment of student and teacher “buy-in” of the pedometer program would be useful to address this question. More fine-grained analysis of in-school physical activity in different locations or times (e.g., while students are in the classroom as opposed to during recess, lunch, or PE class) would also be interesting. Although such assessments were beyond the scope of the current study, these are very important questions that need to be addressed by future research.

In summary, overall step counts continued to increase over the time of the 6-week intervention. Different step goal conditions produced similar effects on children’s physical activity levels across all time points. The use of pedometers in a school-based physical activity intervention is appealing, as they are simple to use and inexpensive. As a motivation tool, the pedometer can be successfully used to monitor and provide incentives for increasing activity levels. Further study is warranted to compare the relative costs and benefits associated with the use of different incentive and goal conditions.

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