An Integrated Curriculum Approach to Increasing Habitual Physical Activity in Children: A Feasibility Study

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ABSTRACT: *A relatively new concept is that of "integrating" physical activity throughout the school curriculum, thereby teaching children about lifestyle physical activity in a variety of contexts. One method by which this may be achieved is by utilizing pedometers as a motivational and educational tool for measuring accumulated physical activity. No research is available that shows in-depth integration of physical activity into the curriculum or that investigates the efficacy of pedometer use for this purpose. The purposes of this study were to (1) design and implement a 4-week elementary school curriculum unit, based around pedometer walking and (2) quantify, using pedometry, the physical activity levels of children (N = 78) prior to, and during, the unit implementation. Results showed that more than one half of the participants were achieving >15,000 steps daily, and children were significantly more active on weekdays than weekends (p = .0001). Boys were more active than girls at baseline (p = .01) and during intervention weekdays (p = .03). Differences between baseline and intervention weekdays were nonsignificant for the complete sample; however, significant increases in step counts were observed when the children with low activity levels, especially females, were examined separately. Overall, the integration of physical activity using pedometer-based activities is feasible. However, any increases in activity may be restricted to children who are least active.* (J Sch Health. 2006;76(2):74-79)

In addition to psychosocial benefits, physical activity provides clear health gains in children, including improved bone health, and reduced risk of developing type 2 diabetes, cardiovascular disease risk factors, and obesity.[1] Current physical activity guidelines for elementary children vary from 30[2,3] to 60 minutes daily.[1] At least twice a week, activities that improve bone health, muscle strength, and flexibility should be incorporated,[1] and an additional 20[2] to 30 minutes[3] of vigorous physical activity is recommended 3-4 days each week, to achieve and maintain cardiorespiratory fitness. The National Association for Sport and Physical Education (NASPE) recommended that children participate in physical education classes for at least 150 minutes per week.[4] Step-based physical activity recommendations for children vary from 11,000 and 13,000 daily steps for girls and boys, respectively,[5] to 12,000 and 15,000 daily steps for girls and boys, respectively.[6]

Considering these recommendations, current data available show that many children in westernized societies are insufficiently active for health gain and/or that physical activity participation in this population is declining.[7-9] To reverse this trend, a number of interventions have been used to increase the activity levels of elementary school-aged children. These have predominantly been school-based, with components including enhancing opportunities for physical activity,[10] encouraging effective use of physical education class time,[10-14] health education,[11,12,15] including the family environment,[12,13,15-19] and involving multiple settings and interdisciplinary approaches.[13,15,20-22]

The latter approach warrants further investigation, as promoting physical activity participation holistically throughout the school environment may enhance the likelihood of behavior sustainability. Using physical activity and pedometers as a teaching medium by which to integrate other disciplines in a school setting may encourage children to accumulate physical activity. This method can also be used to make the concept of improved health through an active lifestyle relevant to all disciplines. Such an approach is considered curriculum integration and is not a new concept in education.[23] Evidence exists to support the academic and social benefits of integrating general disciplines.[24-26] No research has been published that has integrated physical activity and pedometer use throughout the elementary school curriculum.

CURRICULUM INTEGRATION

Integration within a school curriculum can be considered in many different forms. Beane[27] considered integration as holistic, whereby knowledge and skills are drawn from all disciplines, to create a meaningful learning experience. Placek and O'Sullivan[28] stated that true integration requires rethinking traditional teaching concepts and models, and integrating internally within, and externally across, disciplines. As such, these authors were critical of integrated models where concepts were added to existing structures.

However, taking a comprehensive, integrated approach can prove time consuming and problematic. Teachers may have insufficient content knowledge and experience with integration, content areas do not always match well, and terms can differ between content areas.[29,30] These limitations are especially applicable to physical education lessons, as content knowledge in this area is often weaker than traditional disciplines of mathematics and English.[28] Potential reasons for this have been offered by general elementary teachers in Canada, where a lack of infrastructure for physical education, and low prioritization of physical education were primary barriers to effective class instruction.[31]

Few interventions have been published that attempt to integrate physical activity into the school curriculum. The 2-year Eat Well and Keep Moving school program was designed to increase physical activity and reduce television (TV) watching time to under 2 hours daily.[15] Physical

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activity was integrated into existing curriculum structures. Results detailed a nonsignificant decrease in TV time and no evidence for changes in physical activity. These findings may have been confounded by the use of self-report methodologies and the use of different baseline and follow-up measurement tools. Therefore, these results may not adequately show the effect of the program on physical activity and TV time. Even so, such modest changes in TV time may still result in substantial changes in this outcome at a population level.

Another initiative, the Take 10! program,[20] provided teachers with instruction cards for a variety of 10-minute blocks of physical activity related to curriculum objectives for core subjects. Recent findings, as measured by accelerometry, have shown that Take 10! classes used the cards 8-9 times per week, for 10-11 minutes each time, and that children achieved a moderate to vigorous level of physical activity during each session.[32] The Take 10! program shows potential for integrating physical activity within academic disciplines and accumulating physical activity within the school environment. The addition of approximately 80-100 minutes of activity to existing physical education class participation could mean that children might achieve the minimum recommended daily level of physical activity. However, whether children received the recommended 150 minutes of physical education tuition and whether children were sufficiently active throughout physical education classes was unclear. Furthermore, the differing disciplines were not linked, and thus, this approach is not an example of true curriculum integration.

Two elementary school programs that integrated physical activity into the curriculum and linked core disciplines were the Running and Reading Across America program in Alabama, started in 1997,[21] and the Move Across America program, implemented in Kansas since 2001.[22] In both programs, students accumulated mileage by walking or running around their school track, within physical education classes, and/or in their own time during recess breaks. Accumulated mileage was calculated and compared against a map of America. Students were encouraged to reach personal and class goals of traveling to various cities across America. Tools such as pedometers and heart rate monitors were utilized, and cross-curricular learning opportunities were provided between English, mathematics, geography, health, and physical education. No research investigating the effectiveness of these programs and their influence on physical activity levels has been published.

Even so, the use of pedometers in these programs is of particular interest. Pedometry may be useful to integrate physical activity throughout the elementary curriculum. Pedometers provide an objective measure of an individual's physical activity by way of step counts. The concept of accumulating steps to "virtually travel" around a country provides a common theme for linking disciplines. For example, geographic regions "virtually" reached by accumulating step counts may be studied in social studies and English, and pedometer step data collected may be used in statistics and mathematics lessons.

Despite attempts to develop an integrated physical activity curriculum, no research has been published that has evaluated program effectiveness on objectively measured physical activity. Further, the efficacy of pedometer use for this purpose has not been established. Nevertheless, the concept of accumulating physical activity to complete a "virtual walk" around a country appears an ideal strategy to integrate physical activity into the curriculum. The intent of the present research was to investigate the feasibility of implementing an intervention that used pedometry to integrate physical activity throughout an elementary school curriculum. Specific aims were to (1) design and implement a 4-week elementary level integrated curriculum unit based on pedometer-determined accumulated physical activity and the completion of a competitive (between classes) "virtual walk" and (2) quantify the physical activity levels of children prior to, and during, the unit implementation. *A priori* hypotheses were that physical activity participation would increase from baseline measurement during the resource implementation phase, and that boys would be more active than girls.

METHODS

Sample Selection

A convenience sample was recruited from an urban, decile 8 (high socioeconomic status), primary (elementary) school in Auckland, New Zealand, in spring 2004. Three grade 5-6 classrooms comprising 78 children (52% female), aged 8-10 years participated in the study. Assent was gained from all participants, and a parent or guardian of each child signed an informed consent. Ethical approval was granted from the Auckland University of Technology Ethics Committee.

Intervention Materials

A comprehensive, stand-alone primary school unit for grades 5-6 was developed in collaboration with primary school teachers. The unit was developed in line with the New Zealand national curriculum and assessment guidelines. A thematic approach was taken, whereby all disciplines were linked by a common topic of conducting a "virtual" walk around New Zealand. Subjects incorporated were English, social studies, mathematics, statistics, and physical education. Lesson plans required student participation in physical activity, explored physical activity themes, or were related to New Zealand cities that were "walked" to. Examples of how disciplines linked to the theme are provided in Table 1. All lesson plans were preprepared and, where appropriate, differing plans were provided for varying student abilities. Teachers were provided an explanation of the resource upon delivery by a trained researcher. The unit was implemented simultaneously in the classes over 4 weeks.

Data Collection

All children wore 1 Yamax SW-200 DIGIWALKER hip-mounted pedometer (Yamax Corp., Tokyo, Japan) at baseline and throughout the intervention period (4 weeks). Interinstrument pedometer reliability in children has been established with correlations (r; the strength of a relationship between 2 variables) ranging from $r = .92$ to $r = .98$.[33] Validity has been determined in children using accelerometry ($r = .50$-$.98$) and direct observation ($r = .80$-$.97$).[34] Baseline pedometer step data were collected for 3 weekdays. Sealed pedometers were attached at the start of the school day on Monday by a researcher and class teachers and collected at the same time the following Thursday. Children were not

blinded to the function of the pedometers. No feedback on the baseline results was given to the children.

Resource implementation began the following week. Each child was provided with an unsealed pedometer and instructed to wear it every day, including weekends, for the next 4 weeks, except for any time spent sleeping or in water activities. Teachers recorded step counts at the beginning of each school day. Weekend data comprised step counts from Friday through to Monday morning inclusive. Step count data were gathered for 16 weekdays and 3 weekends.

Data Analysis

Data were excluded for children who had missing pedometer readings at baseline, for 2 or more weekdays, or for one or more weekends during the intervention period. Daily averages were calculated for baseline and during the intervention phase (week and weekend days combined). Averages were calculated separately for intervention week and weekend days. One-tail related-sample *t* tests were used to test for significant differences between genders. Within-group data were analyzed using 1-tail paired *t* tests to examine step count differences between baseline and intervention week and weekend days. Equal variance was assumed, and alpha was set at .05.

To minimize potential ceiling effects, participants were sorted by gender, then grouped by baseline activity levels, and data analyses conducted for children categorized as low active. Classifications were based on arbitrary cutoffs determined by the researchers, and existing step-based physical activity recommendations for children,[5,6] to identify trends in intervention effectiveness, and to highlight the subgroup(s) that benefited most from the intervention.

Quartiles were used to identify baseline activity level in relation to other participants of the study. Data of the lowest 3 quartiles were pooled and analyzed (group A). Analysis was conducted for children who achieved less than 15,000 steps per day (group B) and for children achieving less than the current gender-specific step recommendations as described earlier (groups C and D).[5,6] To illustrate the effect of the intervention on children of differing activity levels further, percentage change from baseline to intervention weekdays was also calculated for each group.

Table 1
Examples of Subject Integration Within the Intervention Curriculum Unit

Subject	Example
English	Guided silent and independent reading about the 12 cities "virtually" walked to in New Zealand and shared reading covered historical events from some of the cities visited
Social studies	Investigation of technological change throughout history and resulting influence on changing levels of physical activity participation and methods of physical activity measurement
Mathematics	Calculating stride length by measuring distance walked and number of steps taken
Statistics	Practicing various physical activities (running around 2 chairs, throwing a ball into a bin), estimating the number of times the activity can be completed in 30 seconds, then tallying, and totaling the actual number of times the activity is completed in 30 seconds
Homework	Compiling a list of activities that a friend could do to achieve 30 minutes of physical activity a day

RESULTS

Baseline Characteristics

Data were analyzed for 61 children (1 withdrawal, 16 missing data) and are presented in Table 2. More than one half (56%) of the participants were achieving >15,000 steps daily. Accumulating an average of 18,055 (± 5,574) steps per day, boys were significantly more active than girls, who had a daily average of 14,719 (± 5,891) steps ($df = 59$, $t = 2.27$, $p = .01$). Eighty percent of the sample were achieving recommended daily step counts.

Intervention Results

Data presented in Table 3 show the average daily step counts during the intervention. Boys accumulated approximately 2000 more steps per day than girls during intervention weekdays. This difference was significant ($df = 59$, $t = 1.87$, $p = .03$). No significant gender differences were found for weekend physical activity.

A significant decrease in average daily step counts was measured from baseline to during the intervention phase ($df = 60$, $t = 7.00$, $p = .0001$). Participants were significantly more active on intervention weekdays than weekend days ($df = 60$, $t = 27.05$, $p = .0001$). Considering also that baseline measures were collected for weekdays only, weekend data were excluded from any further analyses, and weekday data alone were used as the measure of physical activity participation during the intervention period. No significant differences were found between baseline and intervention weekdays during the intervention period for the entire sample.

Figure 1 shows the percentage change in activity for the full sample and children deemed low active by the stratifications described previously. Boys in the lowest 3 quartiles (group A) increased average daily weekday steps from 15,466 (± 3176) to 16,340 (± 3550), although this increase was not significant ($df = 21$, $t = 1.27$, $p = .1$). Girls in group A exhibited a significant increase from 12,467 (± 4766) to 14,253 (± 2694) steps daily ($df = 23$, $t = 1.82$, $p = .04$). The percentage change from baseline to the intervention period for boys and girls in group A were 5.6% and 14.3%, respectively.

Significant changes between baseline and intervention were found for both boys and girls who were accumulating less than 15,000 steps daily (group B). Boys in group B increased their average step counts from 12,793 (± 1453) to 14,498 (± 2762) steps daily ($df = 10$, $t = 1.89$, $p = .04$), and girls increased from 10,399 (±

4554) to 13,668 (± 2960) daily steps (df = 15, t = 2.56, p = .01). Percentage changes from baseline to intervention were 13.3% and 31.4% for boys and girls, respectively.

The trend of increased step counts for less active children continued for children in groups C and D. Criteria for boys in group C were the same for group B (i.e, accumulating less than 15,000 steps daily); thus, the findings for boys in groups B and C are identical. Girls in group C increased from 6323 (± 4003) to 12,655 (± 3127) steps during the intervention period (df = 6, t = 2.88, p = .01), corresponding with a 100% increase in physical activity. Boys in group D exhibited a nonsignificant increase from 11,722 (± 1035) steps at baseline to 14,208 (± 3332) steps during the intervention period (df = 5, t = 1.71, p = .07). Girls in group D increased from 5452 (± 3585) to 12,613 (± 3423) average daily steps (df = 5, t = 2.97, p = .02). Table 3 shows the percentage changes for boys and girls in group D as 21.2% and 131.4%, respectively.

Overall, the intervention appeared to have little influence on the physical activity levels of elementary children. However, further investigation showed that the intervention effects were confined to subgroups of this population group. In particular, significant changes in physical activity were found for boys and girls who accumulated less than 15,000 steps daily and for girls in the lowest 3 quartiles of physical activity level. The improvement in activity increased as the baseline activity level decreased, and the increases were greater for girls than for boys.

DISCUSSION

The baseline physical activity levels of the children involved in this study were encouraging. When considering the daily step recommendations for children, a majority of the sample were very active. For example, the President's Council for Physical Fitness and Sports[5] suggested that boys and girls should accumulate 13,000 and 11,000 steps daily, respectively. Eighty percent of the children measured were achieving these recommendations. Even when considering the higher guidelines of Tudor-Locke et al[6] of 15,000 and 12,000 daily steps for boys and girls, respectively, 70% of children could still be considered sufficiently active. However, more work does need to be done in children and adults to equate pedometer steps with specific health outcomes. It would be premature to use any of these recommendations for "sufficiently active" as an evidence-based criterion. As such, any classification should be treated with some caution. It is possible that the high activity levels of the participants in this study may be related to socioeconomic status (as measured by school decile rating). Further research is required to investigate the generalizability of these findings.

An unexpected finding was the significant decrease in daily step count averages from baseline to the intervention phase when including intervention weekend data. However, baseline measures were only collected for 3 weekdays, while the intervention data contained both weekend and weekday data. Furthermore, analysis of weekend versus weekday pedometer steps during the intervention showed that both boys and girls were significantly less active during weekends than weekdays. Thus, this finding was likely confounded by the low weekend step counts that were only present in the intervention data. That weekend physical activity was significantly lower than weekday activity was of particular interest, especially considering that the weekend data included 1 weekday. It is likely that participants were noncompliant on weekend days. As well, it is possible that children were more active on weekdays than weekend days. This is in contrast to previous research, whereby students in grades 1-6 were significantly more active during weekend days than weekdays.[35] This pattern was reversed in older children (grades 7-12). As the children in the present study were near to the latter age group (grades 5-6), it is possible that reduced physical activity in weekends begins earlier than grade 7. This issue highlights the integral role of the family as well as educators in physical activity promotion.

The main aim of the present study was to investigate the feasibility of an integrated curriculum program. The resource package was implemented and yet did not have a significant effect on the physical activity of the group as a whole. Given the relatively high activity levels of the participants, the researchers felt that some of the children may have been experiencing a ceiling effect. In other words, the most active children may have had very little room to increase their activity any further. As such, further analyses were conducted to look at "for whom" the intervention may have been most effective. The intervention significantly increased the least active students' physical activity levels when weekdays were measured. This intervention effect is important and demonstrates objectively for the first time the effectiveness of a physical activity unit integrated across curriculum areas. It also shows the utility of pedometer use in a school setting.

Table 2
Baseline Step Counts of Participants

	Total n	Average Daily Step Counts (± SD)	% Achieving Daily Step Count Recommendations		
			≥15,000	Girls ≥12,000; Boys ≥15,000	Girls ≥11,000; Boys ≥13,000
Total	61	16,305 (±5938)	56	70	80
Boys	29	18,055 (±5574)	62	62	79
Girls	32	14,719 (±5891)	50	78	81

Pedometers may be useful tools in physical activity interventions for children. One reason for this may be their "novelty" factor. Another is that they are able to provide objective feedback on habitual physical activity in a currency which children can easily understand. The utility of pedometers in a school setting may be enhanced when combined with an integrated learning approach such as the "virtual walk." The pedometer lends itself to application across different disciplines because of the simple quantification of physical activity. Similarly, the "virtual walk" facilitates integration as classes can study various cities and related information as they accumulate enough steps to "virtually walk" to each city. Further, the competitive element between classes may create an environment where class members can provide social and logistical support for their peers to be more physically active.

LIMITATIONS

This study had a number of limitations. Convenience sampling meant the participants were not randomized, and were relatively homogenous, limiting the generalizability of the research findings. Baseline measures did not include a weekend day. Due to time and resource constraints, no control or comparison groups were included; therefore, the amount of physical activity change directly attributable to the resource implementation, and/or pedometer provision, could not be quantified in a controlled trial.

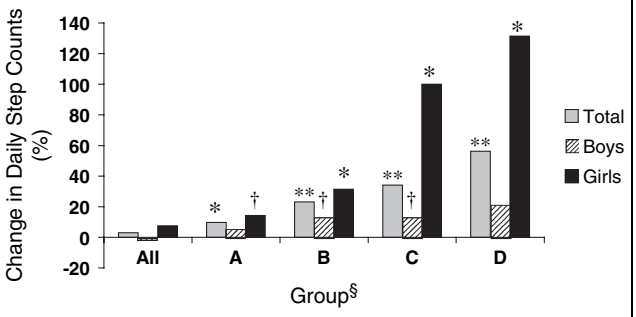
The only outcome measures taken were pedometer steps during the intervention. Pedometers are limited to ambulation, and no measure was taken of other types of activities that students were engaged in. There may have also been other changes in body composition, fitness, and the like which resulted from this intervention. Although physical activity concepts were taught, changes in physical activity knowledge, attitudes, and beliefs of the teachers and students were not measured. Anecdotal reports suggested that teachers found program implementation straightforward and that both students and teachers enjoyed the curriculum unit.

The study was of a short duration, and no follow-up was conducted. Longer term changes in any variables remain unmeasured. It was hypothesized that physical activity participation would increase during the resource implementation, which was observed in specific subgroups of the sample. However, whether these changes were maintained was unclear, as was the influence of season on the resource effectiveness. Sustainability is also an issue for consideration, as continuation of the thematic unit beyond the 4 weeks of lesson plans provided would require significant additional teacher input and planning. Whether changes would continue beyond this period is not known.

Table 3
Average Daily Step Counts During Intervention Weekdays and Weekend Days

	Average Daily Steps (±SD)	
	Weekdays	**Weekends**
Total	16,791 (±4243)	3970 (±1329)
Boys	17,835 (±4549)	3890 (±1422)
Girls	15,844 (±3769)	4042 (±1257)

Figure 1
Percentage Change in Daily Step Counts From Baseline to Intervention Weekdays



**p < .005; *p < .02; †p < .05.
§Group A: top quartile omitted, group B: boys and girls accumulating <15,000 steps daily, group C: girls achieving <12,000 steps daily; boys achieving <15,000 steps daily[6], group D: girls achieving <11,000 steps daily; boys achieving <13,000 steps daily.[5]

CONCLUSION

A limited number of programs currently exist to integrate physical activity into the primary school curriculum, and these may not be considered truly integrative; instead, they are concepts which have been added to an existing framework. At present, little empirical evidence exists that shows improved performance using an integrated curriculum. The present research provides preliminary evidence for the efficacy of an integrative approach to improve the physical activity levels of children. It shows that the combination of pedometers, a virtual walk, and curriculum integration is feasible in a school setting. The long-term maintenance and potential health benefits of such a strategy are unknown but important. At least this approach may provide children with opportunities to be active in a predominantly sedentary environment, present to children the concept of accumulating physical activity, and provide teachers with an inclusive resource to teach across a variety of discipline areas. ■

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