Effectiveness of Peer-Based Healthy Living Lesson Plans on Anthropometric Measures and Physical Activity in Elementary School Students
A Cluster Randomized Trial

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**IMPORTANCE** Schools are considered an attractive setting to promote healthy living behaviors in children, but previous school-based interventions aimed at preventing weight gain in children have yielded mixed results. Novel school-based approaches are needed to modify healthy living behaviors and attenuate weight gain in children.

**OBJECTIVE** To assess the effectiveness of a peer-led healthy living program called Healthy Buddies on weight gain and its determinants when disseminated at the provincial level to elementary school students.

**DESIGN, SETTING, AND PARTICIPANTS** Cluster-randomized effectiveness trial performed during the 2009-2010 school year. Baseline and follow-up measurements were made in October 2009 and May 2010, respectively. The study was performed in 19 elementary schools in Manitoba, Canada, and included 647 elementary school students aged 6 to 12 years (48% girls).

**INTERVENTION** Schools were randomized to receive regular curriculum or Healthy Buddies lesson plans. Lesson plans were delivered by older (9- to 12-year-old) elementary school students to the younger (6- to 8-year-old) peers and targeted 3 components of health: physical activity, healthy eating, and self-esteem and body image.

**MAIN OUTCOMES AND MEASURES** The primary outcome measures were the change in waist circumference and body mass index z score. Secondary outcomes included physical activity (steps per day), cardiorespiratory fitness, self-efficacy, healthy living knowledge, and self-reported dietary intake.

**RESULTS** At baseline, 36% of children were overweight or obese and 11% achieved the recommended 13,500 steps per day. Intention-to-treat analyses showed that waist circumference declined significantly in the intervention group relative to controls: −1.60 cm (−2.28 to −0.91; P < .001). Reductions in waist circumference were particularly significant for children who were overweight or obese or attending First Nations schools. No difference in body mass index z score was observed between groups. Self-efficacy, healthy living knowledge, and dietary intake significantly improved in younger peers who received the intervention compared with students from control schools. No differences were observed in daily step counts or cardiorespiratory fitness between the groups.

**CONCLUSIONS AND RELEVANCE** The implementation of Healthy Buddies lesson plans delivered by older peers within an elementary school setting is an effective method for attenuating increases in central adiposity and improving knowledge of healthy living behaviors among elementary school students. Improvements were achieved with parallel improvements in diet quality, self-efficacy, and knowledge of healthy living.

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Schools are an attractive setting to promote healthy living behaviors in children. Unfortunately, most teacher-led school-based interventions have been ineffective at reducing body weight in children. In contrast to traditional school-based interventions, peer mentoring is an attractive strategy for eliciting behavior change in children. A recent peer-led program called “Healthy Buddies” targeted healthy eating, physical activity, and self-efficacy among elementary school students. Healthy Buddies consists of a set of healthy living lesson plans taught to older students (grades 4-6), who then act as mentors, transferring the knowledge to younger students in the school (kindergarten through grade 3). A pilot trial of Healthy Buddies in a Canadian school showed attenuated weight gain and reduced blood pressure in mentors and mentees respectively, relative to students receiving a standard curriculum. A similar peer-based strategy reduced obesity rates among African American adolescents paired with young adults. Although these data appear promising, the studies used quasi-experimental designs without randomization and were not disseminated at the state or provincial level. The present study was designed to overcome these limitations by using a cluster-randomized effectiveness trial to test the hypothesis that a school-based, peer-led healthy living program would reduce adiposity and increase physical activity among children.

Figure 1. Flowchart

Schools assessed for eligibility

865 Schools assessed for eligibility
804 Schools excluded
32 Schools not meeting inclusion criteria (francophone schools)
772 Schools declined to participate (did not volunteer)

61 Schools enrolled into phase 1

20 Schools randomized

10 Schools (340 students) allocated to intervention (Healthy Buddies)
10 Schools (340 students) received allocated intervention
0 Schools (0 students) did not receive allocated intervention

10 Schools (347 students) allocated to control
9 Schools (307 students) received allocated intervention
1 School (40 students) did not receive allocated intervention (withdrew from study)

30 Students lost to follow-up (absent from class on data collection day)
0 Students discontinued intervention

310 Students completed the trial
0 Students excluded from analysis
340 Students retained in final analysis

34 Students lost to follow-up (absent from class on data collection day)
0 Students discontinued intervention

273 Students completed the trial
0 Students excluded from analysis
307 Students retained in final analysis

Study design and flow of participants through the trial.
sent to study protocols. Children were excluded if consent was not received or if they had a condition that limited participation in physical activity. The study protocol was approved by the Biomedical Research Ethics Board at the University of Manitoba in accordance with the Declaration of Helsinki.

**The Intervention**

The details of the intervention have been described elsewhere. Teachers delivering the Healthy Buddies lesson plans attended a 2-day training seminar at the beginning of the 2009-2010 academic school year. The program content focused on physical activity, promoting healthy foods, and having a healthy body image using the slogans: “Go Move!” (activity), “Go Fuel!” (nutrition), and “Go Feel Good!” (body image). Twenty-one lessons were provided to teachers to be delivered during the school year to older students.

In schools randomized to the intervention, an older class was paired with a younger class. Each week, the older students received a 45-minute healthy living lesson from their classroom teacher. Later that week, the older students acted as peer mentors, teaching a 30-minute lesson to their younger “buddies.” The “Go Move!” aspect included two 30-minute structured aerobic fitness sessions per week, called fitness loops, with the student pairs. Students were trained to complete the fitness loops at a vigorous intensity using perceived exertion scales. The “Go Fuel!” component included lessons about distinguishing nutritious from unhealthy (nutrient-poor, energy-rich) foods and beverages. As part of the “Go Feel Good!” component, students were taught to value themselves and classmates based on individual traits rather than peer influence. The peer-led model facilitated social skills, self-esteem, and social responsibility. A more comprehensive description of the Healthy Buddies program can be obtained at [http://www.healthybuddies.ca](http://www.healthybuddies.ca).

**Outcome Measures**

The primary outcome measures were body mass index (BMI) 2 score and waist circumference. Outcome measures were collected at the beginning (September 2009) and end (May 2010) of the academic calendar year during day visits to each school. Research assistants were blinded to study assignment. The BMI (calculated as weight in kilograms divided by height in meters squared, with height measured in centimeters) was measured in duplicate with a portable floor scale (Seca 869) and stadiometer (Seca 217). Raw BMI values and age in months were used to calculate BMI z scores based on Centers for Disease Control and Prevention growth charts. Waist circumference (in centimeters) was measured by using a flexible tape at the level of the iliac crest using the method established by McCarthy et al.

Secondary outcome measures included physical activity, cardiorespiratory fitness, self-efficacy, healthy living knowledge, and self-reported dietary intake. Healthy living questions were extracted from questionnaires that are considered valid and reliable for children within this age range. Secondary outcome measures are reported assuming randomization occurred at the individual level. Differences in changes in primary and secondary outcome variables between intervention and control groups were tested using a mixed model approach, which was used to control variation at the level of the individual. We also calculated the intraclass correlation to compare variation between school classes as a fraction of the total variance. All comparisons were adjusted for baseline differences in residence (rural vs urban), age, and sex. All analyses were adjusted for random effect of student and within-school clustering using a compound symmetry structure for the within-student correlations. All data were analyzed in an intention-to-treat analysis, with the last value carried forward.

The treatment effect (or effect size) was calculated as the mean gains scored difference (MGSD) = [mean difference (intervention) - mean difference (control)]/pooled SD, where

\[
Pooled SD = \frac{SD of the Treatment Effect}{\sqrt{1 - r}},
\]

where \( r \) is the pre-post correlation (Spearman correlation of the preintervention vs postintervention variable). The 95%
Results

Demographics and Baseline Characteristics
In the fall of 2009, a total of 647 students within 38 classrooms in 19 schools were enrolled into the trial. Ten schools (340 students) were randomized to the intervention arm, and 10 (347 students) to the control arm; 1 school (40 students) withdrew from the study after being randomized to the control group. The flow of participants through the study is presented in Figure 1. Overall, 49% of students attended rural schools, 48% were girls, 36% were overweight or obese, and 11% achieved a minimum of 13,500 steps per day. Baseline participant demographics are presented in Table 1. In the spring of 2010, a total of 584 students from 19 schools repeated the measurements. Reasons for not returning included (1) moving to a different school, (2) withdrawing from school, and (3) being absent during the week of data collection. No differences in outcome measures were noted between completers and noncompleters.

Primary Comparisons
Groupwise differences in the change in the primary outcome measures are presented in Figure 2. Compared with students in the control group, students exposed to the intervention had a significant reduction in waist circumference (−2.00 [95% CI, −2.48 to −1.51] vs −0.40 [−0.89 to 0.09] cm; P < .001). Changes in BMI z score did not differ between the intervention and control groups (0.00 [95% CI, −0.03 to 0.03] vs −0.01 [−0.04 to 0.02]; P = .55). In subgroup analyses, the reduction in waist circumference remained significant in the younger students (ie, buddies) and in the older mentors (Table 2 and Figure 3). In additional subgroup analyses, the effect of the intervention was significantly greater among overweight and obese youth relative to the healthy-weight youth in both younger peers and older mentors (Table 2).

Secondary Outcome Measures
No differences in physical activity were observed between groups in the younger peers. However, among older students, those who received the intervention displayed a reduction in average daily step counts compared with students in the control group (Table 2). At baseline, the knowledge of healthy eating and behavior was similar in older and younger students (Table 3 and Table 4). Among the younger students, the Healthy Buddies lesson plans led to significant improve-

Table 1. Participant Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (95% CI)</th>
<th>Intervention (340 Students)</th>
<th>Control (307 Students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td>9.3 (9.1-9.5)</td>
<td>8.8 (8.6-9.0)</td>
</tr>
<tr>
<td>No. of students by subgroup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary/intermediate</td>
<td>158/182</td>
<td>156/152</td>
<td></td>
</tr>
<tr>
<td>Female/male</td>
<td>182/158</td>
<td>146/161</td>
<td></td>
</tr>
<tr>
<td>Rural/urban</td>
<td>189/151</td>
<td>129/178</td>
<td></td>
</tr>
<tr>
<td>First Nations /non–First Nations</td>
<td>87/253</td>
<td>96/211</td>
<td></td>
</tr>
<tr>
<td>Circumference, cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist</td>
<td>67.8 (66.5-69.1)</td>
<td>65.0 (63.7-66.2)</td>
<td></td>
</tr>
<tr>
<td>Hip</td>
<td>77.8 (76.7-78.9)</td>
<td>75.8 (74.7-77.0)</td>
<td></td>
</tr>
<tr>
<td>Waist-hip ratio</td>
<td>0.87 (0.86-0.87)</td>
<td>0.85 (0.85-0.86)</td>
<td></td>
</tr>
<tr>
<td>Height, cm</td>
<td>136.9 (135.6-138.2)</td>
<td>134.1 (132.8-135.5)</td>
<td></td>
</tr>
<tr>
<td>Weight, kg</td>
<td>36.4 (35.1-37.8)</td>
<td>34.9 (33.1-35.8)</td>
<td></td>
</tr>
<tr>
<td>BMI z score</td>
<td>0.64 (0.52-0.76)</td>
<td>0.55 (0.42-0.68)</td>
<td></td>
</tr>
<tr>
<td>Fitness score*</td>
<td>9.0 (8.6-9.4)</td>
<td>8.4 (8.1-8.7)</td>
<td></td>
</tr>
<tr>
<td>Steps per day</td>
<td>9950 (9339-10 561)</td>
<td>8943 (8493-9394)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index.

* Restricted to mentors.
ments in knowledge of healthy eating and physical activity, self-reported food and drink intake, and self-esteem compared with students in the control group (P < .01 for all variables) (Table 3). These improvements were not observed in the older students (Table 4).

**Discussion**

This cluster-randomized effectiveness trial of peer-based mentoring led to a reduction in waist circumference in elementary school students compared with students receiving a standard curriculum. Healthy Buddies also improved self-efficacy and knowledge of healthy eating among younger elementary school students who learned about healthy living from their older peers. The results of this study suggest that the Healthy Buddies lesson plans have the potential to prevent central weight gain, improve self-efficacy, and enhance healthy living knowledge and behavior among elementary school students when disseminated on a broad scale.

During the past 2 decades, numerous school-based randomized trials have tested the effects of modified curricula, with mixed results. A meta-analysis of school-based physical activity trials revealed limited effects on BMI among school-aged children. Landmark school-based trials found no significant effects of modified curriculum and environmental changes in food provision on measures of weight. However, more recent trials demonstrated that intensive interventions have positive effects on BMI z score or waist circumference. The effects we observed in the present trial are similar to those seen in those earlier trials (mean decrease in waist circumference, approximately 1.5 cm) and were observed without any changes in school environment (eg, food services) or additional programming (eg, after-school activities), suggesting that the positive effects may be attributed to either the novel curriculum or the peer mentoring approach.

Experimental trials of healthy living behaviors typically focus on youth who are overweight or obese. A systematic review of trials for obesity treatment approaches in youth suggest an expected effect size of −0.25 to −0.09 for the change in BMI z score in trials lasting less than 12 months. The effect...
size we observed for the change in waist circumference appears small (−0.12; 95% CI, −0.15 to −0.10) but was greater than expected (equivalent Cohen d = −0.36; 95% CI, −0.51 to −0.20), even though it was observed in a cohort of mostly healthy-weight children. Because this was an effectiveness trial that did not specifically target overweight children, a reduction in waist circumference of approximately 1.5 cm relative to the expected age-related increase is quite robust at the population level. The reduction of central obesity is particularly important because increased visceral adiposity in youth is associated with a clustering of cardiometabolic risk factors in youth\textsuperscript{21-23} and its reduction with decreased cardiometabolic risk.\textsuperscript{24-26}

Observational and experimental studies in youth have demonstrated that higher levels of moderate to vigorous physical activity are associated with lower visceral adiposity.\textsuperscript{25,27,28} This intervention's lack of effect on measures of activity and fitness may be attributed to changes in dietary behavior. Using a modified food frequency questionnaire, younger students reported more frequent consumption of fruits and vegetables combined with reduced consumption of sweetened beverages and sweets. Because these children rely on parents for dietary choices, the data imply that messages provided by the Healthy Buddies lesson plans were transferred to the home environment. Transfer of knowledge from school-based behavior education to the home environment has been documented elsewhere\textsuperscript{38} but would need to be confirmed in follow-up studies.

One key secondary outcome observed in this trial was the improvement in self-efficacy among children exposed to the intervention. Self-efficacy is linked to several healthy behaviors in youth, including fruit consumption, physical activity, condom use, and avoidance of substance abuse.\textsuperscript{31-34} Very few school-based interventions have explicitly measured changes in self-efficacy despite significant evidence that self-efficacy is a robust predictor of health behaviors in youth. One school-based intervention to reduce diabetes risk factors successfully increased self-efficacy among aboriginal Canadian children,\textsuperscript{35} and others have demonstrated limited effects of healthy living programs on measures of self-efficacy, including the original Healthy Buddies pilot study.\textsuperscript{4} It is possible that improvements...
in self-efficacy facilitate the adoption of healthy living behaviors and increase the likelihood of achieving weight loss among youth. Future studies are needed to determine the importance of improved self-efficacy as a mediating factor for successful weight change after lifestyle interventions in children.

This study has several strengths and weaknesses. The primary strength was the use of a cluster-randomized design. The intervention itself (i.e., classroom-based peer mentoring) prohibited randomization at the level of the student. The results from the current experimental design support previous quasi-experimental results.4,5 A second strength was the inclusion of schools from rural and First Nations communities in Manitoba. These communities display higher rates of obesity, sedentary behavior, and chronic diseases in youth.36,37 In the present study, rates of obesity were approximately 80% higher in the rural and First Nations schools, and these students achieved approximately 1000 fewer steps daily. The effects of the intervention on waist circumference were nearly double achieved approximately 1000 fewer steps daily. The effects, coupled with perceived effectiveness and positive support from teachers involved in the program, suggest that the Healthy Buddies lesson plans are a viable and effective option for addressing childhood obesity and increasing healthy living knowledge within elementary schools.

ARTICLE INFORMATION

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Supervision: Santos, Chanoine, McGavock.

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Correction: This article was corrected on November 26, 2014, to fix minor statistical errors and the misspelling of an author’s last name.

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Effectiveness of Healthy Living Lesson Plans


