Pedometers and Text Messaging to Increase Physical Activity: Randomized Controlled Trial of Adolescents with Type 1 Diabetes

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Aim: To assess whether pedometers and text messaging increase physical activity in adolescents with Type 1 diabetes.

Methods: Randomised controlled trial of 12 weeks. 78 participants (14.4±2.37 years, 36 (47%) male). Intervention participants wore an open pedometer and received regular motivational text messages. Control participants received usual care. Primary outcomes were daily step count (4-day closed pedometer) and physical activity (PA) questionnaire.

Results: Baseline median step count 11,063 steps per day (range: 1,541–20,158). At 12-weeks, mean daily step count reduced by 840 (95% CI -1947, 266) steps per day in control group and 22 (-1,407, 1,364) steps per day in intervention group (p=0.4). Mean self-reported moderate or vigorous PA increased by 38.5 minutes per week in control group, 48.4 minutes per week in intervention group (p=0.9).

Conclusion: A 12-week intervention using pedometers and text messaging as motivational tools in adolescents with Type 1 diabetes did not increase physical activity.
Adolescents with Type 1 diabetes require on-going care and support to manage their diabetes (1, 2). Physical activity is an important contributor to glycaemic control (3), has multiple effects on blood glucose, insulin sensitivity, weight management, mental health, social development (4,5), and subsequent cardiovascular disease risk (6), but may not be seen as a priority by the adolescent. Physical activity often declines during adolescence as physical education at school is no longer compulsory, they may stop playing weekend sport, achieve their driver’s license, and start after school or weekend jobs (7, 8).

RESEARCH DESIGN AND METHODS

A 12-week randomized controlled trial was conducted in an outpatient setting from four regional adolescent diabetes services in New Zealand. Participants were aged 11-18 years. Informed consent, enrolment information and baseline measurements were completed prior to randomization. Assessors were blinded at follow-up.

Participants randomized to the intervention group wore an open pedometer every day for 12 weeks, with a goal of at least 10,000 steps per day. The pedometer can be opened by the participant to monitor and record the number of steps taken. Steps per day were recorded on a chart. Each week participants received a motivational text message reminding them to wear their pedometer and be active. Those randomised to the control group received standard care.

Primary outcome measures were change in physical activity measured by 4 day step-count from a closed pedometer, and self-reported physical activity over 7 days measured by a validated questionnaire (9, 10). The pedometer is taped shut so participants do not know the step count. Secondary outcome measures included HbA1c, blood pressure, BMI z-score and quality of life (11). Adherence was monitored in the intervention group by weekly text messages and daily step total charts which were collected at follow-up.

It was estimated that 84 participants would be required to detect, as statistically significant, a difference between the groups of 2000 steps per day or 1.5 hours per week of physical activity (alpha=0.05; p=0.8) (12). Baseline analyses were undertaken in SPSS (15.0) statistical software. Linear regression was used to assess final differences between groups using STATA (9.0). An intention to treat analysis was performed assuming participants with missing follow-up data had no change over 12 weeks. Where variables were missing at baseline, these individuals were not included in final analyses for those variables.

The trial was approved by the New Zealand Central Regional Ethics Committee, CEN/05/08/058 and registered with the Australia New Zealand Clinical Trials Register (ACTRN012605000339651).

RESULTS

Of the 100/154 (65%) adolescents who were eligible and invited to participate, 78/100 (78%) agreed to participate (see flowchart Figure A1 in the online appendix available at http://care.diabetesjournals.org). Forty were randomized to the control group and 38 to the intervention group. Step counts were collected on all participants at baseline. All 38 participants allocated to the intervention group received an open pedometer to wear for 12 weeks. Three participants from the intervention group and one from the control group dropped out prior to follow up (5% attrition rate).

At baseline, participants had a median step-count of 11,063 steps per day (range: 1,541-20,158). Quality of life scores were below the normative range of 60-80% Scale Maximum (%SM), suggesting a lower quality
of life in this group of adolescents compared with others of their age (13). Boys were significantly more active than girls, with higher daily step counts (12,420 (SD 4,919) vs. 10,461 (SD 3,071); p=0.04), higher NZPAQ scores (837 (SD 522) minutes per week vs. 580 (SD 333); p=0.02) and had lower BMI z-scores (0.36 (SD 0.9) vs. 0.74 (SD 0.57); p=0.03).

Table 1 presents baseline characteristics and final results. At 12 weeks, there was no significant difference in change in activity measures between the groups. Daily step count as measured by closed pedometers decreased to a median (IQR) of 10,159 (8,014-14,109) steps per day in the intervention group and 9,982 (8,090-12,465) steps per day in the control group (p=0.2). Differences in secondary outcomes were also not significant at 12 weeks for HbA1c, BMI z-score, quality of life and blood pressure. There was a trend towards lower quality of life in the intervention group.

All 38 participants in the intervention group were texted weekly over the 12-week intervention period unless they notified the principal researcher that they had stopped wearing their pedometer. Seventeen (45%) lost their pedometer but these were all replaced. Fourteen (37%) stopped wearing pedometers prior to follow-up, although 11 of these agreed to wear 4-day closed pedometers at follow-up assessment.

CONCLUSIONS

Pedometers and weekly text messaging as motivational tools did not increase physical activity in adolescents with Type 1 diabetes over a 12-week period. Adherence with pedometers waned in the intervention group, with 37% stopping the intervention before the end of the trial. Although pedometers have ‘gadget appeal’ among adolescents, the appeal was short-lived. More support in addition to a weekly text may be needed to sustain interest.

Due to the limited number of adolescents with Type 1 diabetes in the regions of the study, and the business of the clinics, the sample size did not reach the target of 84. Even with 84 participants the study would have been underpowered to detect as statistically significant the difference of 819 steps per day, instead of the 2000 steps per day estimated. While participation rates (78%) and study retention rates were high (95%), adherence with the intervention was low (37% stopped wearing the pedometer).

There were also potential biases in self-report of physical activity (reliability and over-estimation both of physical activity and adherence with pedometers). In addition, participants could not be blinded to allocation of the intervention, and the motivating effect of the closed pedometer (with reminder texts) at baseline and follow-up may have inflated physical activity estimates in both groups.

There is no consensus about an appropriate target number of steps for adolescents (14, 15). Even so, involving regular physical activity as part of their management remains clinically important and warrants further investigation as to the best method of motivating adolescents to be more physically active.

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REFERENCES


### Table 1: Baseline characteristics and mean changes in primary and secondary outcomes over 12 weeks

<table>
<thead>
<tr>
<th>Primary outcome measures</th>
<th>Baseline Characteristics</th>
<th>Mean Change between Baseline and Follow-up*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (n=40)</td>
<td>Intervention (n=38)</td>
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<tr>
<td></td>
<td>Median (IQR#)</td>
<td>Median (IQR#)</td>
</tr>
<tr>
<td>Daily step count</td>
<td>10,900 (8,324, 13,240)</td>
<td>11,242 (8,380, 13,537)</td>
</tr>
<tr>
<td>Moderate and vigorous physical activity (minutes/week)†</td>
<td>645 (298, 895)</td>
<td>712 (420, 1000)</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>8.50 (7.55, 9.3)</td>
<td>7.95 (7.3, 9.1)</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>114 (104, 123)</td>
<td>115 (106, 126)</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>67 (60, 72)</td>
<td>65 (60, 67)</td>
</tr>
<tr>
<td>BMI z-score</td>
<td>0.64 (0.05,0.98)</td>
<td>0.62 (0.25,1.17)</td>
</tr>
<tr>
<td>Quality of life (SQOL)**</td>
<td>54.9 (53.8,55.8)</td>
<td>55.0 (54.1,56.4)</td>
</tr>
<tr>
<td>Insulin total daily dose (units/kg)</td>
<td>1.1 (1, 1.4)</td>
<td>1.2 (0.9, 1.6)</td>
</tr>
</tbody>
</table>

*Intention to treat analysis assumed that in those where follow-up data were missing (n=4, 5%) there was no change in outcome variable between baseline and follow-up.

# Interquartile range

†Self-reported from the physical activity questionnaire (NZPAQ)

** Subjective Quality of Life score 13