Pedometers and Text Messaging to Increase Physical Activity

Randomized controlled trial of adolescents with type 1 diabetes

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OBJECTIVE — To assess whether pedometers and text messaging increase physical activity in adolescents with type 1 diabetes.

RESEARCH DESIGN AND METHODS — A 12-week randomized controlled trial was conducted. A total of 78 subjects participated in the trial (mean ± SD age 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 questionnaire.

RESULTS — Baseline median step count was 11,063 steps/day (range 1,541–20,158). At 12 weeks, mean daily step count reduced by 840 (95% CI −1,947 to 266) in the control group and by 22 (−1,407 to 1,364) in the intervention group ($P = 0.4$). Mean self-reported moderate or vigorous physical activity increased by 38.5 min/week in the control group and by 48.4 in the intervention group ($P = 0.9$).

CONCLUSIONS — A 12-week intervention using pedometers and text messaging as motivational tools in adolescents with type 1 diabetes did not increase physical activity.

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Adolescents with type 1 diabetes require ongoing care and support to manage diabetes (1,2). Physical activity is an important contributor to glycemic 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 adolescents. Physical activity often declines during adolescence because physical education at school is no longer compulsory; adolescents may stop playing weekend sports, receive a driver's license, participate in after-school programs, or receive 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, enrollment information, and baseline measurements were completed before 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/day. A pedometer can be opened by a 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 a pedometer and be active. Individuals randomized to the control group received standard care.

Primary outcome measures were change in physical activity measured by a 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 was taped shut so participants did not know the step count. Secondary outcome measures included A1C, 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 2,000 steps/day or 1.5 h/week of physical activity ($\alpha = 0.05$; $P = 0.8$) (12). Baseline analyses were undertaken using SPSS 15.0 statistical software. Linear regression was performed to assess final differences between groups using STATA 9.0. An intention-to-treat analysis was conducted 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 Australian New Zealand Clinical Trials Registry (clinical trial reg. no. ACTRN012605000339651).

RESULTS

— Of the 154 potentially eligible participants at the clinics, 100 (65%) were assed for eligibility and 78 (78%) agreed to participate (Figure A1, available in an online appendix at http://care.diabetesjournals.org/cgi/content/full/dc08-1974/DC1). Forty subjects 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

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group and one from the control group dropped out before the follow-up (5% attrition rate).

At baseline, participants had a median step count of 11,063 steps/day (range 1,541–20,158). Quality-of-life scores were below the normative range of 60–80% Scale Maximum, suggesting a lower quality of life in this group of adolescents compared with that in others of their age (13). Boys were significantly more active than girls, with higher mean ± SD daily step counts (12,420 ± 4,919 vs. 10,461 ± 3,071 steps/day, respectively; $P = 0.04$), higher New Zealand Physical Activity Questionnaire (NZPAQ) scores (837 ± 522 vs. 580 ± 333 min/week; $P = 0.02$), and lower BMI Z scores (0.36 ± 0.9 vs. 0.74 ± 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 (interquartile range) of 10,159 steps/day (8,014–14,109) in the intervention group and 9,982 (8,090–12,465) in the control group ($P = 0.2$). Differences in secondary outcomes were also not significant at 12 weeks for A1C, BMI Z score, quality of life, and blood pressure. There was a trend toward lower quality of life in the intervention group.

All 38 participants in the intervention group were sent weekly text messages over the 12-week intervention period unless they notified the principal researcher that they had stopped wearing a pedometer. Seventeen subjects (45%) lost their pedometers, but they were all replaced. Fourteen subjects (37%) stopped wearing pedometers before the follow-up, although eleven 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 to pedometer use waned in the intervention group, with 37% discontinuing the intervention before the 12-week end measurements. Although pedometers have a gadget appeal among adolescents, the appeal was short lived. More support in addition to a weekly text message may be needed to sustain interest.

Table 1—*Baseline characteristics and mean changes in primary and secondary outcomes over 12 weeks*

	Baseline characteristics		Mean change between baseline and follow-up*			
	Control†	Intervention†	Control‡	Intervention‡	Difference between groups‡	P
n	40	38				
Primary outcome measures						
Daily step count	10,900 (8,324–13,240)	11,242 (8,380–13,537)	−840 (−1,947 to 266)	−22 (−1,407 to 1,364)	819 (−916 to 2,554)	0.4
Moderate and vigorous physical activity (min/week)§	645 (298–895)	712 (420–1,000)	38.5 (−95 to 172)	48.4 (−89 to 185)	9.9 (−178 to 198)	0.9
Secondary outcome measures						
A1C (%)	8.50 (7.55–9.3)	7.95 (7.3–9.1)	−0.02 (−0.38 to 0.34)	0.35 (−0.12 to 0.83)	0.38 (−0.21 to 0.96)	0.2
Systolic blood pressure (mmHg)	114 (104–123)	115 (106–126)	−2.1 (−9.1 to 4.8)	−0.0 (−8.8 to 8.8)	2.1 (−8.9 to 13.1)	0.7
Diastolic blood pressure (mmHg)	67 (60–72)	65 (60–67)	−2.0 (−6.8 to 2.8)	−0.7 (−6.2 to 4.9)	1.3 (−5.8 to 8.5)	0.7
BMI Z score	0.64 (0.05–0.98)	0.62 (0.25–1.17)	0.016 (−0.08 to 0.11)	0.006 (−0.07 to 0.09)	−0.009 (−0.13 to 0.12)	0.9
Quality of life (SQOL)	54.9 (53.8–55.8)	55.0 (54.1–56.4)	0.21 (−0.18 to 0.61)	−0.71 (−1.59 to 0.17)	−0.93 (−1.86 to 0.00)	0.06
Other measures						
Insulin total daily dose (units/kg)	1.1 (1–1.4)	1.2 (0.9–1.6)	0.013 (−0.023 to 0.12)	0.015 (−0.016 to 0.136)	0.002 (0.006–0.01)	0.6

*Intention-to-treat analysis assumed that in subjects whose follow-up data were missing ($n = 4$ [5%]) there was no change in outcome variable between baseline and follow-up. †Median (interquartile range); ‡(95% CI); §self-reported from the physical activity questionnaire (NZPAQ). SQOL, subjective quality of life (13).

Because of 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/day, instead of 2,000 estimated. Although participation (78%) and study retention (95%) rates were high, adherence to the intervention was low (37% stopped wearing the pedometer).

There were also potential biases in self-report of physical activity (reliability and overestimation of both physical activity and adherence to 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

1. Milton B, Holland P, Whitehead WM. The social and economic consequences of childhood-onset type 1 diabetes mellitus across the lifecourse: a systematic review. Diabet Med 2006;23:821–829
2. DIAMOND Project Group. Incidence and trends of childhood type 1 diabetes worldwide 1990–1999. Diabet Med 2006;23: 857–866
3. Bernardini AL, Vanelli M, Chiari G, Iovane B, Gelmetti C, Vitale R, Errico MK. Adherence to physical activity in young people with type 1 diabetes. Acta Biomed 2004;75:153–157
4. Wolfsdorf JI. Improving diabetes control in adolescents with type 1 diabetes. In *Practical Psychology for Diabetes Clinicians*. 2nd ed. Anderson BJ, Rubin RR, Eds. Alexandria, Virginia, American Diabetes Association, 2002, p. 149–159
5. Hohepa M, Schofield G, Kolt G. Adolescent obesity and physical inactivity. N Z Med J 2004;117:U1210
6. Williams G, Pickup JC. *Handbook of Diabetes*. Oxford, U.K., Blackwell Science, 1998
7. Pender N. Motivation for physical activity among children and adolescents. In *Annual Review of Nursing Research*. Fitzpatrick JJ, Ed. New York, Springer Publishing, 1998, p. 139–172
8. Richards R, Reeder AI, Darling H. Interest and participation in selected sports among New Zealand adolescents. N Z Med J 2004;117:U906
9. McLean G, Tobias M. *The New Zealand Physical Activity Questionnaires: Report on the Validation and Use of NZPAQ-LF and NZPAQ-SF Self-Report Physical Activity Survey Instruments*. Wellington, New Zealand, SPARC, 2004
10. Moy K, McFarlane K, Scragg R, Robinson S. *Validation of MOH-Short and SPARC-Long Physical Activity Questionnaires: Final Report*. Auckland, New Zealand, SPARC, 2003
11. Cummins RA. *Comprehensive Quality of Life Scale—School Version*. 5th ed. Melbourne, Australia, Deakin University, 1997
12. Elley CR, Kerse N, Swinburn B, Arroll B, Robinson E. Measuring physical activity in primary health care research: validity and reliability of two questionnaires. N Z Fam Physician 2003;30:171–180
13. Petito F, Cummins RA. Quality of life in adolescence: the role of perceived control, parenting style and social support. Behav Change 2000;17:196–207
14. Tudor-Locke CE, Myers AM. Methodological considerations for researchers and practitioners using pedometers to measure physical (ambulatory) activity. Res Q Exerc Sport 2001;72:1–12
15. Tudor-Locke C, Pangrazi RP, Corbin CB, Rutherford WJ, Vincent SD, Raustorp A, Tomson LM, Cuddihy TF. BMI-referenced standards for recommended pedometer-determined steps per day in children. Prev Med 2004;38:857–864