



Short Communication

Behavioral engineering of activity choice in obese children

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This laboratory study examined whether making sedentary activities contingent upon being physically active would increase obese children's physical activity. Fourteen obese children aged 8–12 y participated in a baseline session in which they had free choice among a variety of sedentary activities and riding a stationary bicycle. Children were then randomized to either a contingent group in which watching video cassette recorder (VCR) movies and playing video games were contingent upon riding the bicycle or a control group in which all physical and sedentary activities remained freely available. Contingent group children increased physical activity and decreased television activities in comparison to the control, even though other sedentary activities remained freely available. Findings suggest that highly valued sedentary activities can reinforce physical activities and that sedentary activities do not completely substitute amongst themselves. The automated system used to make television activities contingent upon physical activity has potential for modifying activity in the treatment of obesity.

Keywords: activity choice; obesity; physical activity; behavioral economics

Introduction

Childhood sedentariness is cross-sectionally and prospectively related to obesity.^{1,2} Obese children find sedentary behaviors more reinforcing than physical activity.³ Interventions need to shift obese children's activity choice. One possible approach is to make highly valued sedentary activities contingent upon physical activity in order to increase physical activity.

High-rate activities have been used to reinforce physical activity in previous studies,^{4,5} but such contingencies have neither been tested in obese populations, nor within an activity choice situation. This study evaluates activity choice when some available sedentary activities are made contingent upon being physically active, with remaining sedentary activities not contingent upon physical activity. The inclusion of freely available non-contingent sedentary activities allows children to choose between engaging in physical activity to get access to contingent sedentary activities or reallocating time for the freely available sedentary activities.

Method

Nine obese boys and five obese girls aged 8–12 y participated and were compensated \$50.00 for participation in this study. Obesity was defined as weighing more than 20% above the 50th percentile body mass index (BMI; kg/m²) weight and above the 85th BMI percentile.⁶ The average child was 71.1 ± 26.7% overweight, with a BMI of 30.1 ± 4.8, and a BMI percentile of 98.6 ± 1.6.

On Day 1 (baseline), children were brought individually into a room containing books, video cassette recorder (VCR) movies, Super Nintendo video games (Model SNS-001; Nintendo, Inc., Redmond, WA), drawing/coloring materials and a Tunturi Executive stationary bicycle [Tunturi, Inc., Bellevue, WA]. Children were instructed in equipment operation and given 90 min of free choice among the activities, with the instruction to engage in up to two activities at a time. Child height and weight were then measured using a balance beam scale and laboratory stadiometer.

On Day 2 and Day 3, children were stratified by gender and randomly assigned either to a group in which 1) the targeted sedentary activities of playing video games and watching VCR movies were contingent upon riding the stationary bicycle (Contingent), with non-targeted activities of reading and drawing/coloring freely available or 2) there were no contingencies on any activities (Control). Children

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remained in the same group for both 90 min intervention sessions and were told it was their choice in which activities they engaged. Children were observed through a video camera and activity choice was coded using a 30 s interval timesampling coding system. Total activity time within a session could exceed 90 min, as activities engaged in simultaneously were both coded. One-third of the sessions were independently coded by a second rater, with an average by interval agreement of 96.3%.

The mechanics and programming for the contingency equipment are described elsewhere⁷. On the intervention days for the Contingent group, the television for watching the VCR and playing video games was activated and remained on if and only when children pedaled at a speed of 60 rotations per minute (rpm) and shut off when the pedal speed fell below 60 rpm. Children controlled the resistance on the bicycle.

One-way ANOVAs were used to examine group differences in child age and weight status. Number of intervals spent in physical and sedentary activities (targeted, non-targeted) were assessed using separate two-way ANOVAs for each type of activity, with group (Contingent or Control) as the between subjects variable and day (baseline, intervention days) as the within subjects variable.

Results

There were no significant group differences in age, weight status or baseline activity choice. On the

baseline day, contingent and control group children spent an average of 4.9 and 4.8 min in physical activity, 70.4 and 76.7 min in VCR watching and video game playing, and 37.3 and 19.0 min in reading and drawing/coloring, respectively.

There were significant group by day interactions for physical activity ($F(2,24) = 7.62, P = 0.003$), targeted sedentary activities of video game playing and VCR watching ($F(2,24) = 12.76, P < 0.001$), and non-targeted sedentary activities of reading and drawing/coloring ($F(2,24) = 7.46, P < 0.004$). As shown in Figure 1, the contingency was associated with a reduction in the Contingent groups' VCR watching and video game playing of 43.6 min on intervention day 1 and 39.1 min on intervention day 2 relative to baseline. The decrease in targeted sedentary activity time was reallocated to 20.3 and 26.1 min of physical activity and 21.5 min and 16.0 min of non-targeted sedentary activity on intervention days 1 and 2, respectively. As shown in Figure 1, the Control group showed no significant changes from baseline to intervention days, allocating 80.0 and 76.7 min to targeted sedentary activities during intervention days 1 and 2.

Discussion

Establishing a contingency in which television activities were only available while being physically active substantially increased obese children's physical activity from 5 min during baseline free choice to > 20 min when the contingency was in effect.

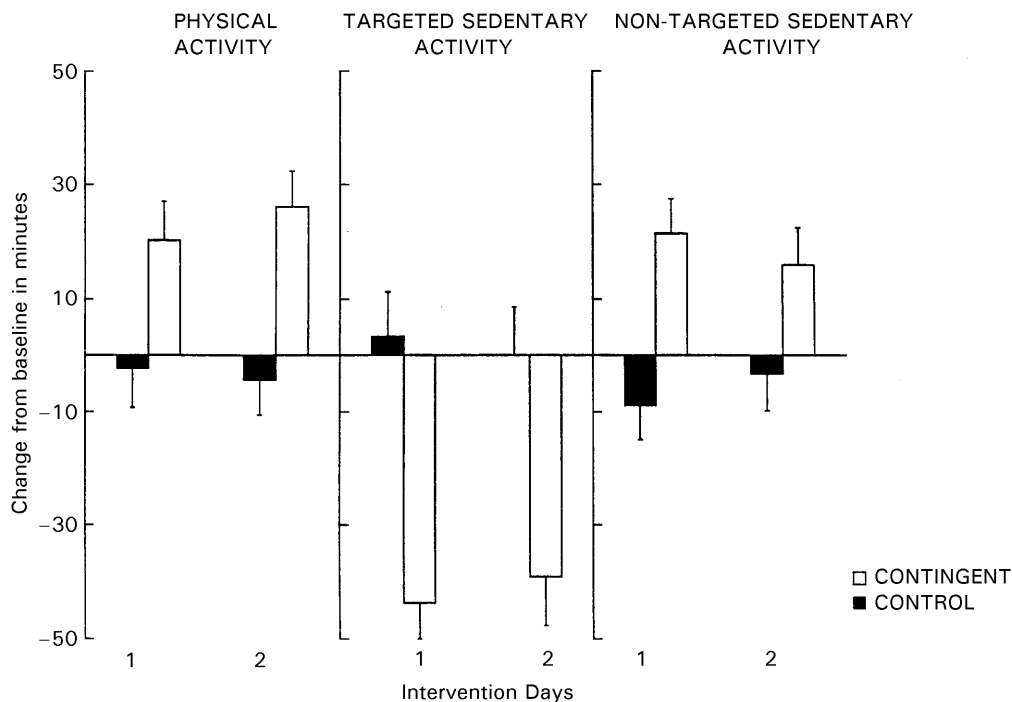


Figure 1 The change (Mean \pm s.e.m. bars) from baseline in physical activity, targeted sedentary activities, and non-targeted sedentary activities in the CONTINGENT and CONTROL groups during the first and second intervention days.

This amount of physical activity approximates the daily physical activity prescription for children and adults.^{8,9}

Findings are consistent with reinforcement models which suggest that behaviors engaged in frequently can reinforce less frequent behaviors if the higher frequency behavior is made contingent upon the lower frequency behavior.¹⁰ However, reinforcement models cannot account for activity choice when behaviors within a contingency and non-contingent activities are available. Behavioral economic theory provides a framework for understanding such activity choice. From a behavioral economic perspective,^{11,12} this study examined whether the lower preference sedentary activities of reading and drawing/coloring would substitute for television activities when the response cost of television activities was being physically active. The contingent group increased their physical activity in order to gain access to the highly valued television activities rather than reallocating time exclusively for lower preference non-contingent sedentary activities. This lack of complete substitutability among sedentary activities is consistent with previous laboratory and clinical outcome studies which found that reductions in a subset of children's sedentary activities were accompanied by physical activity increases and not simply a reallocation of time to non-targeted sedentary activities.^{13,14}

The exercise/sedentary contingency system has wide public health applications for increasing physical activity in sedentary populations. The automatic system eliminates the need for an outside observer (for example, parent) to monitor and reinforce physical activity, but depends upon controlling access to targeted sedentary behaviors. Access to the targeted sedentary activities independent of the contingency would undermine the efficacy of the targeted sedentary activities to reinforce physical activity.

Future research should continue to evaluate the factors that influence activity choice and substitutability, explore techniques for modifying activity choice and examine the long-term efficacy of these interventions.

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