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Adding sprints to continuous exercise at the intensity that maximises fat oxidation: Implications for acute energy balance and enjoyment

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ABSTRACT

The objective was to examine the effect of adding sprints to continuous exercise at the intensity that maximises fat oxidation (Fat_{max}) on energy expenditure, substrate oxidation, enjoyment and post-exercise energy intake in boys. Nine overweight and nine normal weight boys (8–12 years) attended the laboratory on three mornings. First, body anthropometrics, peak aerobic capacity and Fat_{max} were assessed. On the remaining two sessions, resting metabolic rate was determined before participants completed 30 min of either continuous cycling at Fat_{max} (MOD) or sprint interval exercise consisting of continuous cycling at Fat_{max} interspersed with four-second maximal sprints every two minutes (SI). Energy expenditure and substrate oxidation were measured during exercise and for 30 min post-exercise, while participants completed a modified Physical Activity Enjoyment Scale (PACES). This was followed by a buffet-like breakfast to measure post-exercise energy intake. Fat oxidation rate was similar between groups and protocols ($P>0.05$). Both groups expended more energy with SI compared to MOD, resulting from increased carbohydrate oxidation ($P<0.05$), which was not compensated by increased energy intake. Participants indicated that they preferred SI more than MOD, although there was no significant difference in PACES score between the protocols ($P>0.05$). In summary, the addition of short sprints to continuous exercise at Fat_{max} increased energy expenditure without compromising fat oxidation or stimulating increased post-exercise energy intake. The boys preferred SI and did not perceive it to be any harder than MOD, indicating that sprint interval exercise should be considered in exercise prescription for this population.

Abbreviations: BMI, body mass index; CO_2, carbon dioxide; DEXA, dual energy x-ray absorptiometry; Fat_{max}, the exercise intensity that maximises fat oxidation; MOD, 30 min of continuous cycling at Fat_{max}; O_2, oxygen; PACES, Physical Activity Enjoyment Scale; PCERT, Pictorial Children's Effort Rating Table; SI, 30 min of continuous cycling at Fat_{max} interspersed with four-second maximal sprints every two minutes; VAS, visual analogue scale; $\dot{V}O_{2max}$, maximal oxygen uptake; $\dot{V}O_{2peak}$, peak oxygen uptake; UWA, The University of Western Australia; W, watts.

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1. Introduction

Childhood obesity rates are continually on the rise [1] and as a result, exercise for weight control is becoming increasingly important for children. It has recently been proposed that exercise training aimed at Fat_{max} (40%–55% $\dot{V}O_{2peak}$ [2-7]) should be encouraged for weight management [8,9] and may be more effective than other exercise intensities in reducing the risk of medical consequences associated with obesity such as insulin resistance [10]. However, although exercise at this moderate intensity may maximise fat oxidation rates during the exercise bout, higher intensity exercise has been associated with increased fat oxidation rates post-exercise [11]. Furthermore, the increased energy expenditure resulting from high intensity exercise may be more effective in inducing a negative energy balance required for weight loss [12]. Based on this, there is considerable debate as to the optimal exercise intensity required for weight management in both adults and children.

The major concern with prescribing continuous high intensity exercise to overweight and obese individuals is that they may find the strenuous training load unpleasant [13,14] and therefore, are not likely to adhere to a program of this nature in the long-term [15]. This could be particularly true for overweight children who may lack the motivation to participate in, or be less likely to withstand the discomfort associated with, sustained high intensity exercise. A promising alternative is sprint interval exercise which involves low to moderate intensity exercise or rest, interspersed with short (≤1 min) supramaximal (>100% O_{2max}) sprints. This type of exercise has a pronounced effect on energy expenditure both during the exercise bout and post-exercise [16,17], and has been shown to promote greater fat loss [18,19], than traditional endurance training. Furthermore, due to the fact that children often engage in spontaneous physical activity, characterised by unstructured games or sports that require multiple short sprint efforts interspersed with longer duration low and moderate intensity exercise [20], it may be more appealing for overweight children to participate in sprint interval exercise than continuous exercise to promote better long term adherence and fat loss. However, studies examining the enjoyment of acute bouts of exercise (i.e. specific intensities and protocols) appear to be limited to adult cohorts [13-15]. Given that enjoyment could be one of the most influential factors to increase a child's adherence to an exercise program [21], there is a specific need to examine this in children.

Another important consideration in exercise prescription for weight management is the effect of exercise intensity on post-exercise energy intake. It is possible that any additional energy expenditure resulting from sprint interval exercise may be of no benefit if there is greater compensation in energy intake from the post-exercise meal. Therefore it is important to consider both the energy expended during exercise and the energy consumed after exercise to fully understand the potential influence of different types of exercise on weight management. An acute suppression of appetite after high-, but not low-, intensity exercise has been noted in adults [22-24]. To our knowledge, no studies have examined the effect of sprint interval exercise on appetite and post-exercise energy intake in adults or children. It is important to examine individuals with varying body composition given that differences in post-exercise energy intake have been observed between normal weight and overweight children [25].

Given the potential for exercise at Fat_{max} to increase fat oxidation during exercise, and that of sprint interval exercise to enhance enjoyment and energy expenditure, without stimulating increased energy intake, the purpose of this study was to examine the addition of short sprint efforts to continuous exercise at Fat_{max} on energy expenditure and substrate oxidation (inclusive of the acute post-exercise recovery period), enjoyment and post-exercise energy intake in overweight and control boys. It was hypothesised that sprint interval exercise would increase energy expenditure, suppress energy intake and be more enjoyable compared with continuous exercise at Fat_{max}. However, it was expected that the addition of short sprint efforts to continuous exercise at Fat_{max} would compromise fat oxidation rates.

2. Methods

2.1. Participants

Twenty four participants were initially recruited to participate in this study. Of this, six completed the first session but were unable to continue as a result of their inability to maintain a constant cycling cadence which was essential for the experimental trials. As a result, nine overweight (10.7±2.4 years) and nine normal weight (control; 10.1±1.8 years) boys completed all experimental procedures and were included in the final analysis. Although pubertal status was not directly assessed, the age range was selected to focus on pre-pubertal boys only. This status was supported by parental confirmation. Human ethics approval was granted by the Human Research Ethics Committee at UWA prior to recruitment and before involvement in the study, Child Assent was obtained.

2.2. Research design

All participants attended the Laboratory on three mornings, each separated by at least five days. All sessions were completed at the same time of morning within participants to control for diurnal variation, after at least a 10-h overnight fast. On the first session, anthropometry and body composition were assessed and participants completed a graded exercise test to determine $\dot{V}O_{2peak}$ and Fat_{max}. For the two subsequent visits, energy expenditure and substrate oxidation were determined before, during and after 30 min of continuous moderate intensity cycling at Fat_{max} (MOD) or continuous cycling at Fat_{max} interspersed with four-second maximal sprint efforts (selected to reflect the spontaneous physical activity patterns of children [20]) every two minutes (i.e. 29-min MOD and 1-min maximal sprint efforts; SI), administered in a randomised counterbalanced order. In addition, enjoyment and post-exercise energy intake were assessed for each protocol. All participants were instructed to maintain their normal diet between testing sessions. However, they were asked to complete records of all food and drink