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ORIGINAL ARTICLE

Sustained improvements in fitness and exercise tolerance in obese adolescents after a 12 week exercise intervention



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Received 14 January 2015; received in revised form 30 March 2015; accepted 2 April 2015

KEYWORDS

Aerobic fitness;
Anaerobic threshold;
Exercise tolerance;
Adolescents;
RESIST

Summary A 12 week exercise program was evaluated for its effect on aerobic fitness, anaerobic threshold, physical activity and sedentary behavior levels in obese insulin resistant adolescents post intervention and at follow up. 111 obese insulin resistant 10–17 year olds were recruited to a 12 month lifestyle intervention, known as RESIST. From months 4 to 6, adolescents participated in supervised exercise sessions twice per week (45–60 min/session). Aerobic fitness and anaerobic threshold were measured by gas analysis at baseline, 6 months (post intervention) and 12 months (follow up). Self-reported physical activity and sedentary behavior was measured using the CLASS questionnaire. At 6 months aerobic fitness and time to

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reach the anaerobic threshold had improved by 5.8% [95% CI: 0.8–11.3] and 19.7% [95% CI: 10.4–29.0], respectively compared with baseline. These improvements were maintained at 12 months. Compared to baseline, 6 month physical activity levels increased by 19 min/day [95% CI: 5–33] and screen time decreased by 49 min/day [95% CI: 23–74] but returned to baseline levels by 12 months. Improved fitness and anaerobic threshold can be sustained up to 6 months following completion of an exercise program possibly enhancing capacity to perform daily functional tasks.

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Introduction

Adolescent obesity is a global public health concern associated with poor aerobic fitness and suboptimal physical activity levels [1,2]. This places obese adolescents at increased risk of cardiometabolic complications, including insulin resistance and type 2 diabetes [3]. Obesity, poor fitness, low physical activity levels and cardiometabolic complications are known to track into adulthood and predict premature death [4,5]. Therefore, effective interventions are necessary to achieve improved long-term health outcomes.

Twelve week exercise intervention programs to treat obesity in adolescents have achieved improved aerobic fitness [6–9], weight related outcomes [6,9] and cardiometabolic risk factors [6–8] following the intervention. However, few studies examine the long-term sustainability of physiological improvements associated with an adolescent exercise program [10].

The anaerobic threshold is a useful predictor of aerobic fitness [11] as well as a measure of exercise tolerance [12] and is decreased in obese adolescents [13,14]. Poor exercise tolerance, as indicated by an early anaerobic threshold, is likely to have an effect on an obese adolescent's ability to perform daily functional tasks. Exercise interventions can lead to improvements in the anaerobic threshold in adults [15]; however, this has not yet been described in adolescents.

Hence the aim of this study was to examine the effect and sustainability of a 12 week exercise program on aerobic fitness, anaerobic threshold, physical activity and sedentary behavior in obese insulin resistant adolescents. We hypothesized that aerobic fitness, anaerobic threshold, physical activity and sedentary behavior levels would improve following a 12 week exercise intervention compared with baseline. We also hypothesized that positive effects would be sustained at follow up, 6 months from completion of the exercise intervention.

Methods and procedures

This paper presents secondary data analyses of a 12 month randomized control trial, known as RESIST, which examined the efficacy of two different diets to improve insulin sensitivity in adolescents with clinical features of insulin resistance and/or pre-diabetes treated with metformin. The study protocol [16] and results reporting weight outcomes at 6 and 12 months [17,18] have been previously published.

The study was approved by the Human Research Ethics Committee of The Children's Hospital at Westmead (07/CHW/12), Sydney South West Area Health, Western Zone (08/LPOOL/195) and Sydney South West Area Health Service, Royal Prince Alfred Hospital (08/RPAH/455). Written informed consent was sought from the parent and assent from the adolescent prior to enrolment in the study.

Participants

The RESIST study recruited overweight and obese (International Obesity Task Force age-sex adjusted definitions [19]) 10–17 year olds with pre-diabetes and/or insulin resistance and at least one other clinical feature of insulin resistance [16]. Pre-diabetes was defined by the American Diabetes Association (impaired fasting glucose >5.6 mmol L⁻¹ and/or impaired glucose tolerance >7.8 mmol L⁻¹) [20] and insulin resistance was defined as a fasting insulin (pmol L⁻¹) to glucose (mmol L⁻¹) ratio greater than 20.

Exercise intervention

Fig. 1 outlines the RESIST study exercise intervention timeline conducted at The Children's Hospital at Westmead, Australia. In phase 1 (0–3 months), adolescents received standard physical activity advice during individual consultations at baseline, 2, 6 and 12 weeks. Advice was consistent with the Australian Government recommendations for children and adolescents which include reducing

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