

The BASES Expert Statement on the Role of High-intensity Interval Exercise for Health and Fitness Promotion in Young People

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Kathryn Weston, Prof Alan Barker, Dr Bert Bond, Sarah Costigan, Dr Charlotte Ingul and Prof Craig Williams FBASES.

Introduction and background

High-intensity interval exercise (HIIE) is characterised as brief, intermittent bouts of intense activity (e.g. 85 to 95% maximal heart rate¹ or 80 to 100% peak work rate²), interspersed with periods of rest/lower intensity recovery. The last 15 years has seen renewed scientific interest in HIIE, possibly due to suggestions that, compared to longer continuous bouts, the intense, intermittent nature of HIIE more closely resembles young people's physical activity patterns. Further, there is accumulating evidence that time spent in higher intensity activities may be an important predictor of cardiometabolic health in youth (e.g. Tarp *et al.*, 2018; Carson *et al.*, 2014). This expert statement draws on studies that explored acute and chronic responses to HIIE in young people (≤ 18 years) undertaken in laboratory, clinical and school settings, for the purposes of health, well-being and fitness promotion.

intervals at $\sim 90\%$ maximal aerobic speed with 75 seconds of recovery) elicited higher enjoyment due to feelings of reward, excitement and success when compared to a bout of moderate intensity exercise. In contrast to concerns about participants experiencing unpleasant feelings during HIIE (Biddle & Batterham, 2015), youths did not report negative feelings during this HIIE protocol. However, affective evaluations during HIIE are likely to be dependent on work interval intensity and delivery (increasing, decreasing or constant).

HIIE in overweight and obese young people and paediatric clinical groups

Over the last decade, the role of HIIE in managing paediatric obesity has been studied extensively. In 2018, a large multi-site randomised control trial was published (Dias *et al.*, 2018). This was followed by a meta-analysis (Thivel *et al.*, 2019), which identified

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Acute physiological and perceptual responses to HIIE

Investigating short-term responses to single bouts of HIIE may be conceptually important, as chronic exercise benefits may be related to repeated acute exercise episodes. Such studies observed how an acute HIIE bout alters health outcomes immediately after and up to 48 hours post exercise. Important methodological considerations when examining acute responses to HIIE include: controlling for confounding variables such as habitual physical activity and diet up to 48 hours prior to each experimental condition; and delivering the conditions in a counterbalanced manner to control for order effects.

The most recent review of HIIE's acute health benefit is by Bond and colleagues (Bond *et al.*, 2017), which identified 14 studies. The authors outlined that an acute HIIE bout, performed on a treadmill or cycle ergometer, reduced postprandial lipaemia and improved glycaemic control and insulin sensitivity in youths when compared to the control condition, but this effect was similar to a bout of moderate intensity exercise. Studies have also shown an acute HIIE bout causes favourable changes in vascular endothelial function and blood pressure in youths when compared to control and moderate intensity exercise and in fasted and postprandial states (Bond *et al.*, 2017).

Studies examining the acute perceptual and psychological responses to HIIE in youths (e.g. Malik *et al.*, 2018) showed a laboratory-based running HIIE protocol (8 x 1 minute work

15 studies published prior to early 2017, involving overweight and obese young people aged 6 to 18 years. Typically, HIIE interventions took place over ~ 12 weeks (range 3 to 24), with ~ 3 weekly sessions provided (range 2 to 10). The HIIE was usually performed using running- and/or cycling-intervals of 15 seconds to 4 minutes. Study comparators included continuous aerobic exercise, no-exercise controls and a multicomponent weight management programme.

Collective evidence indicated HIIE as an effective means of improving cardiorespiratory fitness in overweight and obese young people - at least as effective as continuous aerobic exercise training (Thivel *et al.*, 2019). Recent findings suggest HIIE may be superior to continuous aerobic exercise in improving cardiorespiratory fitness (Dias *et al.*, 2018), however, more work is needed to confirm these initial observations. While improvements in blood pressure, waist circumference, insulin resistance, triglycerides and high-density lipoprotein cholesterol have also been observed following HIIE, these are similar to continuous aerobic exercise induced changes, and sometimes occur without improvement in body size and composition. The role of HIIE in body mass reduction in overweight and obese young people remains unclear.

On the potential of HIIE for therapeutic benefits in paediatric disease groups, case studies have shown HIIE to augment cardiorespiratory fitness in young people with cystic fibrosis (Hulzebos *et al.*, 2011) with some improvements in short-term glycemic control in youths with type 1 diabetes (Cockcroft *et al.*, 2017). Further work is needed to examine the feasibility, safety and efficacy of HIIE for managing health outcomes in paediatric clinical groups.

¹ Maximal heart rate can be defined as the highest value obtained during maximal exercise or can be estimated using a prediction equation (American College of Sports Medicine, 2014).

² Peak work rate can be defined as the highest value obtained during a maximal exercise test (American College of Sports Medicine, 2014).

School-based HIIE

In young people, schools are the most common non-laboratory setting for HIIE interventions given the access to large, ethnically and socioeconomically diverse populations of young people. Fifteen school-based trials were identified in the most recent review (Bond *et al.*, 2017), with > 10 additional studies published since. Typically, HIIE sessions are conducted 2 to 3 times weekly, over ~7 weeks (range 2 to 15). In secondary schools, HIIE is often performed during physical education (PE), whereas in primary schools HIIE tends to be in addition to PE. Most school-based models incorporate work intervals of 10 to 60 seconds, with a work:rest ratio of ≥ 1 . Interval numbers range from 4 to 40, depending on work interval length. Encouragingly, exercise intensity quantification and reporting are relatively commonplace, which is key for assessing HIIE intervention fidelity. Alongside traditional running and cycling, school-based protocols have also incorporated HIIE activities based on ball/invasion games, boxing, skipping, dance and pre-existing fitness equipment.

School-based HIIE can increase cardiorespiratory fitness and may improve some body composition measures (e.g. waist circumference and percentage body fat) and systolic blood pressure (Bond *et al.*, 2017). Largely, HIIE effects were compared to normal PE and/or continuous aerobic exercise and studies involved secondary school pupils, with few conducted in primary schools. This highlights the need for research in younger children, alongside further examination of school-based HIIE effects on other traditional and novel cardiometabolic risk markers. Exploring the impact of HIIE on young people's mental health (broadly categorised as cognitive function, well-being and ill-being) is also an important avenue for future research. Preliminary data from two school-based HIIE interventions in older adolescents suggests school-based HIIE may improve some aspects of mental health (e.g. increases in executive function and reductions in psychological difficulties) (Costigan *et al.*, 2016; Leahy *et al.*, 2019). However, these data can only be considered as pilot due to small and homogenous samples. Data on young people's enjoyment levels of HIIE in the school setting is lacking. While there are some preliminary data to suggest that adolescents may enjoy HIIE, these data have been collected in acute laboratory-based studies (e.g. Malik *et al.*, 2018), which do not mirror the often group-based environment of school-based HIIE protocols. Accordingly, more research in this important area is needed.

Conclusions and recommendations

- HIIE can benefit aspects of young people's health and fitness. The intervention period is typically ≤ 12 weeks and long-term follow-up is scarce, which should be addressed in future research.
- The impact of age, sex, maturity status and body size on young people's physiological and perceptual responses to HIIE is poorly understood. Consideration should be given to the measurement of confounding variables and compensatory behaviours such as diet, sleep and non-intervention physical activity.
- Little is known about HIIE effects on young people's mental health. This should be explored using a variety of mental health outcomes.
- Future HIIE studies should more closely replicate young people's physical activity preferences and patterns and be translated to "real-world" settings. As young people tend to perform physical activity throughout the day, comparing the accumulation of HIIE to a single HIIE session is warranted. Multi-activity HIIE protocols should also be supported.
- To build on the evaluation of school-based HIIE, insights from those directly involved (e.g. pupils and teachers) should be sought via a process evaluation.
- We caution against generalising findings from specific youth groups to wider populations and recognise that HIIE represents one possibility in a menu of physical activity options for young people. ■



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