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LOW-VOLUME HIGH-INTENSITY INTERVAL TRAINING FOR CHILDREN WITH OBESITY: A COMMENTARY

Jaak Jürimäe

Institute of Sport Sciences and Physiotherapy, University of Tartu, Tartu, Estonia

ABSTRACT

Obesity is the most common chronic disease in childhood, and is a risk factor for cardiovascular diseases (CVD) later in life. Being obese is inversely associated with physical activity and cardiorespiratory fitness (CRF) in children. Increased CRF may negate the detrimental effects of obesity-associated risk factors for CVD, while poor CRF has been associated with increased arterial stiffness and higher levels of blood inflammatory markers. The use of time efficient high-intensity interval training (HIIT) to reduce CVD risk factors and body mass, improve CRF and other health parameters has become popular during the last years in adults with obesity. However, a relatively few studies have investigated the effect of HIIT on body composition, CRF and cardiometabolic biomarkers in children with obesity. It is expected that low-volume HIIT programs are feasable for community-based body mass reduction and health promotion in children with obesity.

Keywords: *high-intensity interval training, body composition, cardiorespiratory fitness, blood biomarkers, childhood obesity*

INTRODUCTION

Obesity in childhood is a risk factor for cardiovascular diseases (CVD) later in life [2]. Being obese is inversely associated with physical activity (PA) and cardiorespiratory fitness (CRF) [36]. Increased CRF may negate the detrimental effects of obesity-associated risk factors for CVD [8], while poor CRF was related to an increased arterial stiffness and impaired arterial dilation capacity in children [39]. Assessment of arterial stiffness and carotid artery intima-media thickness (IMT) has become important tool to discover early CVD risk factors and myeloperoxidase (MPO) is an early inflammatory biomarker of vascular dysfunction [13]. Increased PA normalizes vascular dysfunction associated with obesity in children [40]. However, PA appears to be relatively low in children [37] and one of the main barriers to achieve regular PA is a lack of time and motivation [46]. Given that only 28% of children in Estonia meet the current PA guidelines [25], and that children with obesity have lower PA compared with healthy-weight children [24], an effective body fat mass (FM) loss strategies are needed [8]. The inclusion of supervised training provides a potent stimulus for increasing CRF and reducing FM [8]. Moderate-intensity continuous training (MICT) is a good stategy for FM loss [38], while it may be ineffective due to the relatively monotonous training modality [35]. The lack of time, motivation and adherence are the most commonly cited reasons for not exercising [30].

INTERVAL TRAINING

Although MICT reduces CVD risk factors [10] in addition to a decrease in FM [38] and an increase in CRF [30] in obese youth, interval training has increased in popularity [12]. Interval training has the potential to induce FM loss together with health benefits similarly to MICT, while requiring less time [8]. Advantages of interval training over MICT at improving overall health have been reported in adults with obesity [42]. MICT has been defined as a continuous effort that elicts 60–80% of the maximal heart rate (HRmax) and lasts from 30 to 60 min per session [27]. Interval training can be more enjoyable for children as it is possible to manipulate some of at least 9 variables in interval training (work interval intensity and duration, relief interval intensity and duration, exercise modality, number of repetitions and series, between-series recovery duration and intensity) [5]. Interval training interventions can be rather heterogeneous and the most suitable combination for maximizing health improvements is not known. Interval training can be separated into high-intensity interval training (HIIT) or sprint interval training (SIT) [41]. HIIT can be further divided by high-volume HIIT as > 15 min of HIIT in total during the session, and low-volume HIIT as ≤ 15 min of HIIT in total during the session [41]. High-volume HIIT includes repeated intervals of near maximum efforts (e.g., 4 × 4 min intervals at 85% HRmax), while low-volume HIIT has fewer or shorter intervals (e.g., 6 × 1 min at 95% HRmax) and SIT is defined as supramaximal exertion (e.g., 8 × 20 s all-out) with active recovery between intervals [41]. The most used HIIT is the 4 × 4 min bouts format [38] and this type of HIIT performed 2–3 times per week for 8 to 16 weeks improved lipid profile, body composition and CRF in adults [6, 26]. This type of 12-week HIIT program increased CRF without altering FM or cardiometabolic biomarkers in 7–16-year-old children with obesity [8]. The SIT program involving 4–6 bouts of 30 s all-out efforts 3 times per week for 8 to 12 weeks also reduced FM and improved CRF in adults [6, 26]. The health improvements after 12-week of rather low-volume SIT (80 × 6 s sprints + 9 s rest between sprints) and MICT (cycling at 60% peak oxygen consumption [VO_2peak] for ≈ 60 min) were similar, while SIT was more time-efficient and enjoyable to perform [32]. Interval training requires about 40% less training time commitment than MICT [42]. FM loss after HIIT may be similar [19] or higher [4] than after MICT. HIIT may elicit greater FM loss even if the energy expenditure (EE) obtained with HIIT exercise is lower [34] or equal [33] to that during MICT. These results can be attributed to the effects of HIIT on metabolism, promoting increased EE and fat utilization, which seems to be associated with glycogen depletion immediately following interval training [20]. Vigorous exercise may be mediated by a higher increase in skeletal muscle oxidative capacity [45], and training protocols that rely more on a glycolytic system might be more beneficial for FM loss [43]. Accordingly, interval training could be superior over MICT to decrease FM in obese subjects.

Considering differences between interval training variations [38], it is important to analyze training protocols in detail to get further insight how these variations would be suitable for FM loss. It is important to measure blood biomarkers that are involved in the metabolic regulation after MICT, HIIT and SIT sessions to better understand the responsivness of specific exercises to induce FM loss [14]. There could be a wide inter-individual variability in the biological responses to a given exercise [14], and most studies still report this biological response to a single exercise or a training program as a group average [22, 44]. However, it is of potential relevance to analyze biomarkers at an individual level as responder or non-responder in the context of personalized exercise prescription [41]. A rather large inter-individual variability exists in the acute biomarker's responses to HIIT and SIT sessions, while individual analysis shows that most adults had a positive response of measured biomarkers to at least one session type [14]. This analysis has not yet been done for children with obesity.

Myokines such as irisin, myostatin and interleukin [IL]-6 are involved in the metabolic homeostasis due to their release as a result of acute exercise [9, 11, 14]. Irisin has a potential for the prevention and treatment of obesity due to its role in enhancing systemic metabolism by increasing EE [23]. Irisin was increased after HIIT but not after MICT exercise in overweight female adolescents [1]. Higher irisin was correlated with body mass index (BMI), waist circumference, insulin and endothelial progenitor cells in children with obesity [7]. HIIT session also triggers a relase of inflammatory mediators such as vascular endothelial growth factor-1 (VEGF-1), angiopoetin-2 (Ang-2) and platet-derived growth factor (PDGF) [44]. VEGF-1 is an essential factor to increase capillary density and oxygen delivery, which in turn increase exercise performance [44]. Increased post-exercise VEGF-1 was related to metabolic demand measurements including exercise EE of MICT session [18], and acute HIIT increased post-exercise VEGF-1 [21]. Ghrelin and peptide YY also provide metabolic benefits and promote weight management mainly through their influence on appetite and exert a role on glucose homeostasis [14]. In addition to appetite-regulating hormones, exercise-mediated negative energy balance may contribute to the regulation of adipokines [15] and osteokines [16]. Acute MICT increased adiponectin and osteocalcin, which were related to exercise total EE and lipid EE rates [16]. Osteocalcin may also have a role in the development of insulin resistance [17]. Exercise appears to be one of the major links between different modulators of energy intake and output [15], and different biomarkers could be used to characterize the effects of acute MICT, HIIT and SIT exercises in the context of weight management.

Although HIIT and MICT have comparable health outcomes in laboratory settings, effectivness studies in real-world environments are still lacking [29]. The adherence of subjects in participating in interval training programs in real-word conditions, where they can choose their own time to exercise, has not been well studied [28]. To the best knowledge, no studies have been performed to study the adherence of children with obesity to particiapte in group settings of interval training in a community-based fitness centre, similarly to a recent study in adults [28]. Only 14 (5 × 1 min) and 15 (2 × 4 min) min per session at 85–95% HRmax or 28 and 30 min per week, respectively, was needed to complete HIIT in comparison with MICT, where 38 min per session and 76 min per week was needed in this 8-week study with adults [28]. All three training modes improved CRF but the low-volume HIIT protocols required 60% less time commitment. Only 5 × 1 min HIIT decreased waist circumference [28]. At least 12 sessions are needed to elicit CRF adaptations as a result of HIIT [31], while SIT with all-out efforts is superior over HIIT in order to decrease FM in adults [26]. There is also a lack of data about the long-term effect on weight management after the cessation of interval training programs. The treatment for obesity should provide at least 26 contact hours to achieve any sustained success in weight management in children with obesity [3]. Low-volume SIT protocols appear to be most time-efficient, more enjoyable and easier to follow in real-world settings such as in community-based fitness centres, especially when these protocols are performed in groups to enable encouragement from other participants.

CONCLUSION

The proposed interval training programs are effective in increasing CRF and decreasing FM in addition to other health benefits in children with obesity. It is excpected that the used interval training programs are effective tools in weight reduction and and are less time consuming, enjoyable and easy to perform in comparison with traditional MICT programs, which are rather monotoneous and more time consuming. The lack of time, motivation and adherence are the most commonly cited reasons for not exercising in overweight populations and the proposed interval training programs that can last as little as 15 min per session could overcome the time consuming MICT sessions. The results demonstrate that interval training sessions can be done in community settings without heavy supervison. These easy to perform interval training sessions could be successfully adobted to physical education lessons at school, or the children can perform these training sessions by themselves, when going for a run outdoors. However, the use of different interval training programs in community settings, including at school and outdoors requires further research. The personilized approach of data analysis should also be considered as it may help to guide the participants to choose the exercise modality that best suits for each individual in weight management.

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Correspondence to:

Professor Jaak Jürimäe
Institute of Sport Sciences and Physiotherapy
University of Tartu
Tartu
Estonia
E-mail: jaak.jurimae@ut.ee