

Editorial

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Toward the Minimal Volume of Exercise for the Prevention and Treatment of Type 2 Diabetes and Pre-Diabetes

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Editorial

Impaired glucose tolerance (IGT, 2h glucose 140-199 mg/dl), impaired fasting glucose (IFG, fasting glucose 100-125 mg/dl) and Type 2 diabetes (T2D) are conditions characterized by varying levels of insulin resistance causing hyperglycemia on the background of an insulin secretion defect. Patients with IGT and/or IFG are often regarded as having pre-diabetes. Rising levels of obesity and insufficient physical activity are independent risk factors for insulin resistance/diabetes [1]. In fact, these have resulted in a high prevalence of pre-diabetes (35% in American adults, 2008) and T2D (8.3% in Americans, 2011) [2]. Moreover, the prevalence of T2D is increasing rapidly in the US and throughout the world [2]. T2D is associated with substantial human costs in terms of reduced quality of life and life expectancy, and management of the symptoms and secondary complications of T2D accounts for a considerable proportion of total public health care expenditures. Exercise training is a recognized, although relatively underutilized strategy that is central to the prevention, care and management of T2D and pre-diabetes [3].

Public health guidelines generally recommend that adults perform least 150 mins/week of moderate-intensity aerobic physical activity or a minimum of 60 mins/week of vigorous-intensity exercise to promote health [4]. Unfortunately, most people fail to meet even the minimum physical activity guidelines, citing lack of time as the major barrier to regular exercise participation [5]. As such, innovations in exercise prescription that show benefits despite a minimal time commitment therefore represent a valuable strategy to prevent and treat pre-diabetes and T2D.

In an attempt to overcome this obstacle to exercise participation, low-volume high-intensity interval training (HIT) regimes, which could induce similar favorable metabolic adaptations associated with traditional high-volume endurance training, have been developed. Babraj et al. [6] first reported that a two-week HIT program, comprising a total of 15 mins of exercise (three sessions per week; 4-6 × 30-s cycle sprints [repeated Wingate tests] per session), could improve post-training glucose tolerance in young males [6]. Subsequent studies further demonstrated marked increases in insulin sensitivity after a period of two weeks of this training regimen in healthy [7] as well as overweight adults [8]. However, this type of training (Wingate sprints) is extremely demanding and requires strong motivation, and thus may not be safe or practical for some individuals. Recently, less demanding protocols have also been utilized in T2D patients. Little et al. [9] reported that as little as 30 mins of vigorous exercise per week, within a total exercise time commitment of 75 mins/week, improved glucose control, measured by continuous glucose monitoring, in patients with T2D. Over two weeks, eight subjects completed six high-intensity interval exercise sessions, with each session consisting of ten 60-s bouts on a leg cycle ergometer that elicited ~90% maximal heart rate, interspersed with 60 s of rest. Average 24-h blood glucose was reduced by 13% and postprandial blood glucose by 30%. Low-volume HIT may, therefore, represent a potent, time-efficient exercise strategy to improve glycemic regulation in overweight adults, as well as in patients with T2D.

The minimum threshold for exercise to effectively improve insulin sensitivity has been of interest for time-constrained exercisers. Recently, Metcalfe et al. [10] used 10-mins exercise sessions consisting of low-intensity cycling (60 W for warm-up, recovery intervals and cool-down) and two brief "all-out" sprints (15-20 sec). Despite relatively high inter-individual variability, insulin sensitivity significantly increased by 28% in sedentary but healthy males following six weeks of intervention (three exercise sessions per week, and as little as 1.5-2 mins of vigorous exercise per week) [10]. This elegant study suggests that a very brief and feasible exercise intervention is associated with improvements in metabolic health and is a time-efficient alternative for improving risk factors of T2D.

Some important issues for future research include optimization of the type and nature of HIT protocols, individual glucose metabolic responses to HIT and the suitability of HIT for special populations. In the case of HIT, exercise intensity is far more likely to be limited by co-morbidities including cardiovascular disease, peripheral vascular disease or osteoarthritis, making vigorous exercise difficult or impossible in such individuals. Nevertheless, for resistance training, high-intensity exercise is generally possible even in the face of co-morbidities. It is interesting to note that a minimal one-set high-intensity resistance training program that required little time to complete (~11-15 mins per session) resulted in substantial acute [11] and chronic [12] increases in energy expenditure, suggesting that minimal resistance training may provide a sufficient stimulus to impact energy balance and prevent long-term weight or body fat gain. This promotes the idea of observing the glucose metabolic effects of resistance training with minimal time commitment in future studies.

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