



Editorial: Optimizing Exercise for the Prevention and Treatment of Type 2 Diabetes

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Keywords: exercise, diabetes mellitus, type 2, motivation, lifestyle interventions, prediabetes

Editorial on the Research Topic

Optimizing Exercise for the Prevention and Treatment of Type 2 Diabetes

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Specialty section:

This article was submitted
to Diabetes,
a section of the journal
Frontiers in Endocrinology

Received: 08 November 2017

Accepted: 25 April 2018

Published: 11 May 2018

Citation:

Karstoft K, Safdar A and Little JP
(2018) Editorial: Optimizing Exercise
for the Prevention and Treatment of
Type 2 Diabetes.
Front. Endocrinol. 9:237.
doi: 10.3389/fendo.2018.00237

INTRODUCTION

That exercise is beneficial for the prevention and treatment of type 2 diabetes (T2D) is not a novelty, and exercise is indeed regarded as a front-line therapy in T2D (1). In recent years, increasing attention has focused on how to manipulate the exercise stimulus to optimize beneficial responses. As such, factors, including intensity, volume, timing, and potential interactions with diet and medication have each, and in various combinations, been suggested to play pivotal roles in exercise efficacy. Despite this encouraging research, the optimal exercise strategy is far from determined, which is why this Research Topic was introduced.

This Research Topic consists of 10 articles, of which five contain original data and five are review/opinion articles. A broad range of themes are covered, ranging from clinical effects of different types of exercise, to mechanisms underlying exercise-induced improvements in metabolic markers, and expanding to perspectives on why exercise may be important for hard endpoints and how motivation toward physical activity may be regulated.

INTERVAL TRAINING MODALITIES

Interval training, especially high-intensity interval training (HIIT), has in the recent years gained momentum in prevention and treatment of T2D. As a result, HIIT was recently—for the first time—included in the ADA position stand about physical activity/exercise and diabetes (2), as outlined by Colberg, with HIIT now being recommended as an alternative approach to continuous aerobic exercise for some individuals with diabetes. Since some researchers have argued that the inclusion of HIIT in the treatment of metabolic diseases is premature given that only few and small studies exist in relevant populations (3), it is of high interest that several large HIIT studies are included in this Research Topic (Phillips et al.; Francois et al.; Alvarez et al.). This includes the largest published HIIT trial, to our knowledge, in individuals with prediabetes [$N = 189$ (Phillips et al.)]. Overall, these studies suggest that supervised HIIT robustly improves glycemic control and other cardiovascular risk factors in individuals with or at risk for T2D. In contrast, HIIT does not seem to affect basic metabolic rate (Karstoft et al.). All together, these studies report results from $N = 304$ individuals undergoing HIIT, advancing the notion that HIIT is a feasible and effective training strategy, also in participants with metabolic disease.

MECHANISMS

Bearing the above-standing beneficial effects of HIIT in mind, and also acknowledging that HIIT may be superior to moderate-intensity continuous training (4–6), it is of interest to assess which mechanisms that are responsible for the improvements in cardiovascular risk factors seen with HIIT. In this context, several insightful articles are included in the Research Topic. As reviewed by Carson, myokines are proteins that are released by muscles and have auto-, para-, and/or endocrine functions; some of which are known to affect cardiovascular risk factors. Several of the known myokines are induced by contraction, and given that this induction is dependent on exercise intensity (7), it is intriguing to speculate that some of the effects of HIIT are mediated *via* contraction-induced myokines. Also relevant in this context, Eshghi et al. showed that the timing of exercise may be important, since exercise-induced increase in systemic levels of the myokine IL-6 is only seen following the first of two similar exercise bouts performed at one single day. The idea of so-called “non-response” or individualized responses to exercise training is a hot, yet somewhat controversial, topic in the field (8). This was addressed in a preliminary report from Alvarez et al., which suggested that baseline insulin resistance might influence certain cardiometabolic responses to HIIT in women.

In a comprehensive review, Parker et al. reviewed the complex interplay between oxidative stress, antioxidant defense, and physical activity. Whereas both inactivity/obesity on one side and acute exercise on the other side results in increased systemic levels of oxidative stress, the effects on glycemic control and insulin sensitivity are opposing. Parker et al. suggests that differences in intracellular signaling and antioxidant defense may be responsible for these discrepancies. Again, given that the effect of exercise on oxidative stress is dependent on exercise intensity (9), it may be speculated that some of the improvements seen with HIIT are dependent on changes in oxidative stress and antioxidant defense.

NEW INSIGHTS

Whereas the HIIT-induced improvements in cardiovascular risk factors are interesting, it must be acknowledged that little is known about the effects of HIIT (and other types of exercise) on hard endpoints. Given that high postprandial glucose excursions are suggested to be more deleterious than elevated mean

blood glucose levels for cardiovascular risk factors (10, 11), and since postprandial exercise is known to effectively reduce glucose excursions (12), Erickson et al. suggest that exercise for T2D subjects should in general be prescribed post-meal and individualized according to the need, with large glucose excursions requiring longer and more intense exercise bouts compared to small glucose excursions.

For benefits of any type of exercise, the need to adhere is fundamental. The review by Rueggsegger and Booth provides exciting new insights into the importance of the mesolimbic system in controlling motivation and physical activity behavior *via* dopaminergic signaling. Understanding these processes is imperative if the general trend in the population, where physical activity levels are decreasing, is to be reversed.

PERSPECTIVES

Papers in this Research Topic highlight that exercise has a role in the prevention and treatment of T2D. Whereas HIIT seems to be effective for improving cardiovascular risk factors, we still need to characterize the mechanisms underlying the improvements seen in order to develop even more effective training programs for individuals with or at risk for T2D. Moreover, whereas efficacy of supervised HIIT is evident, effectiveness of unsupervised “real-life” HIIT is largely unknown and limited to small studies (13, 14). In order for HIIT and other novel types of exercise to be implemented clinically, more work is needed. Interdisciplinary research involving mechanisms like myokines, oxidative stress, and brain reward systems coupled with innovative real-world trials of HIIT and traditional exercise seem an exciting avenue for optimizing exercise for the prevention and treatment of T2D.

AUTHOR CONTRIBUTIONS

KK and JL drafted the manuscript with input from AS. All authors approved the final version.

FUNDING

JL is supported by a Canadian Institutes of Health Research (CIHR) New Investigator Salary Award (MSH-141980) and a Michael Smith Foundation for Health Research (MSFHR) Scholar Award (16890).

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