# A COMPARISON OF HIGH-INTENSITY INTERVAL TRAINING IN DIFFERENT POPULATIONS

RESEARCH FROM THE SCIENTIFIC ADVISORY PANEL

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High-intensity interval training (HIIT), which involves brief, vigorous exertion interspersed with periods of rest or low-intensity aerobic exercise, is a popular form of exercise that produces significant results in less time than more moderate types of training. Traditionally, HIIT has been reserved for athletes and those who have advanced levels of conditioning, but more and more research is being conducted with HIIT as the primary mode of exercise for people with health limitations.

While HIIT appears to be an effective exercise modality for various types of individuals (e.g., those who have chronic disease and/or who are sedentary, recreationally active or elite athletes), the most effective exercise intensity, and the durations of work and rest intervals are not known.

Additionally, HIIT's effectiveness in promoting regular participation in physical activity in a largely sedentary population remains to be seen. The vigorous exertion required in HIIT may be a deterrent for sedentary individuals because engaging in such training requires high levels of motivation and confidence, and is likely to evoke a negative affective response, which may lead to subsequent avoidance of further exercise. If health and fitness professionals determine that HIIT is appropriate for their clients, implementing this modality of exercise should be done in a thoughtful, gradual progression so that clients achieve success with each experience.

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## KEY POINTS

- HIIT programs have been shown to produce significant results in both fitness and health improvement and get it done in less time.
- HIIT involves brief, vigorous exertion, interspersed with periods of rest or low-intensity exercise typically centered on traditional aerobic modalities such as walking, running and cycling.
- In the sparse amount of research that does exist on HIIT and special populations, it has been shown to improve cardiorespiratory fitness in those with coronary artery disease and congestive heart failure, and in middle-aged adults with metabolic syndrome and individuals with obesity.
- Several studies have shown that the increase in cardiorespiratory fitness after HIIT was superior to what was observed after continuous moderate-intensity training.
- From a public health perspective, discovering an exercise program that takes less time could be an important finding, considering that lack of time continues to be one of the most commonly cited barriers to regular exercise participation.
- An important consideration is that, for sedentary individuals, the strenuous nature of HIIT is likely to be a deterrent to participation.
- More research is needed to clarify the best approaches for recommending HIIT for improving markers of health and fitness.

**HIGH-INTENSITY** interval training (HIIT) is becoming increasingly popular as a method of exercise that produces significant results with a lesser time commitment than more moderate types of training. Traditionally, HIIT has been reserved for athletes and those who have advanced levels of conditioning, but more and more research is being conducted with HIIT as the primary mode of exercise for people with health limitations. The reason for the heightened interest is simple: HIIT programs have been shown to produce significant results in both fitness and health improvement and get it done in less time.

The concept of interval training has emerged as an attractive option for exercise programming because people often cite lack of time as a barrier to exercise participation. Although time is always a factor, interval-training considerations also include physical ability (e.g., does the participant have the capacity to perform higher-intensity exercise?) and emotional response (e.g., does the participant have the desire to perform vigorous activity?).

There are two similar concepts in interval training that should be distinguished: high-intensity training (HIT) and HIIT. HIT programs may include a mix of aerobic, core strengthening, weight training, gymnastics and endurance elements, typically performed at high intensity with little recovery time between exercises. Examples of HIT programs include CrossFit®, Insanity® and TRX®. Programs such as these have emerged and become popularized in the past 15 years. Unfortunately, the research in this area is scarce.

This paper focuses on HIIT, which involves brief, vigorous exertion, interspersed with periods of rest or low-intensity exercise typically centered on traditional aerobic modalities such as walking, running and cycling. There are various formatting options for work and recovery ratios that encompass a considerable range of exercise intensities, resulting in myriad ways to program a HIIT workout. Some researchers have recently defined HIIT as "either repeated short (<45 seconds) to long (two to four minutes) bouts of high-, but not maximal-, intensity exercise, or short (<10 seconds, repeated-sprint sequences) or long (>20–30 seconds, sprint interval session) all-out sprints, interspersed with recovery periods."[1] In this description, maximal, all-out sprint training is the form of vigorous exertion at the highest

end of the intensity spectrum. The optimal recommendation for the duration and intensity of recovery periods following high-intensity activities in HIIT is unknown. However, in reviewing the literature, researchers have surmised that a bout of high-intensity activity (e.g., 30 seconds) is typically followed by three to four minutes of recovery at around 60 to 70 percent of maximal heart rate (MHR).[2]

Because the exercise intensity is varied during a single exercise bout of HIIT, the total volume and/or average exercise intensity can be increased, which can lead to similar or greater improvements in cardiorespiratory fitness and such health markers as blood lipoproteins, glucose, interleukin-6, tumor necrosis factor-alpha and muscle fatty-acid transport compared with single-intensity exercise in healthy adults. Improvements in cardiorespiratory fitness have also been found in persons with metabolic, cardiac or pulmonary disease who perform HIIT, compared with low- or moderate-intensity endurance exercise.[3]

The extent of HIIT's safety and effectiveness is not known for diverse populations or in terms of varying interval characteristics (e.g., exercise intensity and work and rest interval durations). As such, the long-term effects and the safety of HIIT are important considerations that remain to be evaluated.

## HIIT IN RESEARCH

One of the most frequently studied types of HIIT formats is the Wingate protocol, which consists of 30 seconds of all-out cycling effort against a supra-maximal workload on a stationary ergometer. Participants typically perform four to six work bouts separated by approximately four minutes of recovery, for a total of two to three minutes of intense exercise during a training session that lasts about 20 minutes. This format provides a relatively low volume of highly intense exertion. In research studies using the Wingate protocol, athletic subjects have experienced increased skeletal muscle oxidative capacity, increased resting muscle glycogen content, a reduced rate of glycogen utilization and lactate production during matched-work exercise, an increased capacity for skeletal-muscle lipid oxidation, enhanced peripheral vascular structure and function, improved exercise performance and increased maximal oxygen uptake.[4–7] These findings are similar to those that occur after traditional endurance-focused training, which are in line with public recommendations for improving cardiorespiratory fitness. However, these results occurred after a minimal time investment of several weeks of training versus several months, as is typically required in the traditional training protocols. Given the extremely demanding nature of the Wingate test, it may not be safe or appealing for some individuals. As such, protocols that employ low-volume and extreme exertion are typically reserved for healthy and fit subjects.

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To make interval training applicable to different populations, including people at risk for chronic metabolic diseases, Gibala and colleagues[8] designed a more practical model of low-volume HIIT. The researchers decreased the absolute intensity of the work bouts, while increasing their duration and shortening the rest intervals, and designed a practical HIIT model that consists of 10 sets of 60-second work bouts at a constant-load intensity that elicits approximately 90% of MHR, interspersed with 60 seconds of recovery. The protocol is time efficient in that only 10 minutes of exercise is performed over 20 minutes of training. Compared to Wingate-based HIIT studies and traditional high-volume endurance training, the researchers found that their new low-volume practical model was still effective at inducing skeletal muscle remodeling toward a more oxidative phenotype.[9] Although this new model appears promising, it must still be tested through continued research.

In the sparse amount of research that does exist on HIIT and special populations, it has been shown to improve cardiorespiratory fitness in those with coronary artery disease and congestive heart failure, and in middle-aged adults

with metabolic syndrome and individuals with obesity.[10–13] Two studies have shown that as few as six sessions of either Wingate-based HIIT or the more practical constant-load model (60 seconds of work followed by 60 seconds of rest, as described in the previous paragraph) over two weeks improve estimated insulin sensitivity in previously sedentary, overweight individuals.[14,15] Notably, several studies have shown that the increase in cardiorespiratory fitness after HIIT was superior to what was observed after continuous moderate-intensity training.[11,12,16,17] Further, compared with continuous moderate-intensity training, HIIT showed greater improvement in endothelial function[11,12,16,17] and beneficial changes in various components of resting blood pressure[14,18,19] and left ventricular morphology.[11] Gibala and colleagues[8] hypothesized that these beneficial effects could be due to the short intense bursts of activity with HIIT, which induce a spike of cellular and peripheral vascular stress, while effectively sparing the heart from those stresses due to the brief duration of the exercise bouts. However, this hypothesis has not been adequately studied.

## MOTIVATION AND ADHERENCE WITH HIIT

From a public health perspective, discovering an exercise program that takes less time could be an important finding, considering that lack of time continues to be one of the most commonly cited barriers to regular exercise participation.[20–23] Further, if HIIT is thought of as more pleasing than moderate-intensity endurance exercise, participants might be more motivated to perform it. Bartlett and colleagues[24] found evidence to suggest that HIIT is perceived to be more enjoyable than moderate-intensity continuous exercise, at least among recreational runners. In their study on the affective response of previously inactive subjects who performed HIIT on a cycle ergometer, Jung and colleagues[25] found that HIIT was considered more pleasurable than continuous vigorous-intensity exercise, but less pleasurable than continuous moderate-intensity exercise. In their discussion, Jung et al.[25] contended, "*It is plausible that the intermittent nature of HIIT evokes a series of breaks from negative affective responses. Over and above decreasing monotony of continuous exercise, intervals may serve to cause a 'rebound effect' with affect, such that during recovery intervals participants feel considerably more pleasure. The work intervals may be serving to repeatedly bolster confidence within a single exercise session, as well as increase enjoyment through the continual perceived switch between 'on-off' work. Consequently, participants have the ability to push themselves out of their 'comfort' zone for a known, and perceivably manageable, period of time with the knowledge of an approaching period of recovery before performing the same behavior again. This enables participants to tackle each interval individually rather than the constant strain required during continuous vigorous-intensity exercise.*"

An important consideration is that for sedentary individuals the strenuous nature of HIIT is likely to be a deterrent to participation, as several theories in behavioral science, including social cognitive theory,[26] achievement motivation theory[27] and self-determination theory,[28–30] contend that a high level of motivation and competence are needed to participate in regular physical activity. Sedentary and deconditioned individuals typically do not feel competent or confident in the physical domain and, as such, may not engage in strenuous activity.[31] Moreover, the motivation and effort required to participate in high-intensity exercise is much greater than that needed to perform activities of a moderate intensity (e.g., walking),[32,33] which suggests that non-exercisers would have a difficult time adopting a new behavior that included HIIT. For example, Perri and colleagues[34] studied sedentary adults' adherence to specific exercise prescriptions and found significantly greater adherence in the moderate-intensity condition compared to the high-intensity condition. In a more recent study that looked at HIIT in a community setting, subjects were placed in either a low-intensity walking group or a selection of two HIIT groups. Ultimately, the walkers adhered better than the highest intensity group over the 12 weeks of the study.[2]

Further complicating matters is the fact that properly performing a HIIT session may not be more time efficient than a low- or moderate-intensity training session. That is, to cycle through a minimum of four, 30- to 60-second work intervals followed by an equal number of three-minute rest breaks typically requires at least 20 minutes—and this does not include a warm-up or cool-down. Hence, a person would still need to allot at least 30 minutes in order to participate, which does fall in line with the time component of the public recommendations for daily physical activity for health,[35] but does not represent a significant time savings.

## PRACTICAL RECOMMENDATIONS

More research is needed to clarify the best approaches for recommending HIIT for improving markers of health and fitness. The potential for relatively efficient gains in fitness and rapid turnaround of declining health values (e.g., cardiometabolic factors) must be compared against the potentially demotivating effects of high-intensity exercise and the absence of any significant time savings associated with HIIT. If a health and fitness professional deems that adding HIIT to a client's exercise program is warranted, the following practical guidelines may be of value.

- As a general principle, intervals should start out relatively brief (initially about 20 to 60 seconds), with an approximate hard-to-easy ratio of 1:3 (e.g., a 60-second work interval followed by a 180-second recovery interval), eventually progressing to a ratio of 1:2 and then 1:1.
- The duration of these intervals can be increased in regular increments, depending on the goals of the exerciser, but should be increased cautiously over several weeks depending on the client's fitness level.
- As a general principle, the exercise load should be increased by no more than 10 percent per week.
- Initially, a frequency of two HIIT workouts per week is a good starting point. Over time, add more days, while still paying attention to rest and recovery. The number of days per week that an individual can tolerate HIIT depends on numerous factors (e.g., current state of fitness, goals and desire).
- Progression can be achieved by increasing the time of each interval and then moving to a 1:1 work-to-recovery (hard-to-easy) interval ratio. As the client progresses, intervals can progress at a 1:3 work-to-recovery ratio, progressing first to longer intervals and then eventually moving to intervals with a 1:1 work-to-recovery ratio.

## SUMMARY

HIIT appears to be an effective exercise modality for physiological benefit in various types of individuals (e.g., those who have chronic disease and who are sedentary, recreationally active or elite athletes), although the most effective exercise intensity and work and rest interval durations are not known. However, HIIT's effectiveness in promoting regular participation in physical activity in a largely sedentary population remains to be seen. The vigorous exertion required in HIIT may be a deterrent for sedentary individuals because engaging in such training requires high levels of motivation and confidence and is likely to evoke a negative affective response which may lead to subsequent avoidance of further exercise. If health and fitness professionals determine that HIIT is appropriate for their clients, implementing this modality of exercise should be done in a thoughtful, gradual progression so that clients achieve success with each experience. Further, it may be inaccurate to promote HIIT as providing a significant time savings, compared to the established public health recommendations for physical activity and exercise.


## ABOUT THE AUTHOR

Sabrena Jo, M.S., has been actively involved in the fitness industry since 1987. An ACE Certified Group Fitness Instructor, Personal Trainer, and Health Coach, Jo teaches group exercise, owns and operates her own personal-training business, has managed fitness departments in commercial facilities, and lectured to university students and established fitness professionals. Jo serves as Senior Exercise Scientist for the American Council on Exercise (ACE), developing and delivering educational content in the form of textbooks, articles, videos, and online courses. She has a bachelor's degree in exercise science, as well as a master's degree in physical education from the University of Kansas, and has numerous certifications in exercise instruction. Jo acts as a spokesperson for ACE and is involved in curriculum development for ACE continuing education programs. Additionally, Jo presents lectures and workshops to fitness professionals internationally and has authored chapters in numerous ACE texts.

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