Research Bites, May 2021, by Mary Yoke, PhD, FACSM, MA, MM

How Does a Person with Knee Osteoarthritis Do HIIT?

High-intensity interval training (HIIT) is more popular than ever, and its efficacy has been validated in numerous studies, several of which are discussed in this very issue. However, for people with musculoskeletal challenges, HIIT, even though it offers many benefits, can be problematic and may exacerbate pain and dysfunction, depending on the modality and the specific musculoskeletal problem. For example, HIIT modalities that involve high impact, such as running, sprinting, jumping jacks, kickboxing, and several HIIT exercises commonly performed in group settings, may not be appropriate for those with arthritis, plantar fasciitis, Achilles tendonitis, and the like.

A recent article by Smith-Ryan et al (1) examined the feasibility of a HIIT program in patients with knee osteoarthritis. Osteoarthritis is a leading cause of disability, with 12-16% of the U.S. population reporting knee pain as a result. In the Smith-Ryan study, 13 adults (average age of 59.9 years, average BMI of 29.0, 77% female) completed an experimental pilot study. All participants specified moderate to severe knee pain on the Western Ontario and McMasters Universities Index (WOMAC). Assessments collected before and after the program included oral blood glucose tolerance tests and other blood assays, perceived pain scores, body composition measurements using DXA, and cardiorespiratory fitness tests using cycle ergometry (VO_2peak protocol).

What exercise did the participants do? The study design involved supervised HIIT indoor cycling for 6 weeks, two times per week. After warming up, participants performed ten repetitions of one-minute bouts of cycling at 90% of their previously measured peak power outputs (a one-minute rest interval occurred between each bout).

As might be expected, cardiorespiratory fitness significantly improved; however, BMI did not (six weeks may not be enough time for significant reductions in BMI). Importantly, the HIIT cycling program did significantly reduce osteoarthritis pain symptoms, and knee function improved markedly. Although some of the initial participants dropped out due to issues such as difficulty walking the 500 feet from their cars to the testing facility and/or problems mounting and dismounting the bike, the 13 remaining participants showed excellent compliance with no adverse effects. The authors evaluated the relationships between several other metabolic and blood biomarkers and surmised that exercise training, skeletal muscle metabolic health, and

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osteoarthritis pain and function are linked. It should be noted that this was a small, pilot study, with no control group. Even so, the results are encouraging: not only were participants with knee pain able to successfully perform HIIT on cycle ergometers, their knee pain was substantially reduced as a result. This is good news!

Does HIIT Suspension Training Improve Sleep and Decrease Fatigue in Older Adults?

A randomized, controlled trial, conducted by Jiménez-García et al (2), which examined high-intensity and moderate-intensity training (HIIT and MIIT), is interesting and illuminating from at least three perspectives.

First, the authors chose to use suspension training as the exercise modality. Suspension training is generally low-impact (which may be important for participants with musculoskeletal issues such as knee replacements or arthritis), yet it also provides substantial benefits in terms of muscle activation and balance. Second, an older population (age > 60 years, 82 participants) was assessed. Third, the outcome variables in this study were sleep quality and overall fatigue. Many older people report increasing sleep difficulty and increased tiredness with age; poor sleep quality has been linked to increased risk of falls, decreased physical activity, obesity, and mortality (3).

The study was designed to explore the relationship between 12 weeks of HIIT and MIIT, utilizing TRX suspension training, on sleep quality and fatigue levels in older adults. Participants were randomly assigned into either a HIIT group, MIIT group, or control group. Variables such as BMI, self-reported sleep quality (using the Pittsburgh sleep quality index), and fatigue (using the fatigue severity scale) were assessed both before and after the 12-week training period. The exercise protocol for both the HIIT and MIIT groups consisted of training twice per week, with the HIIT group performing TRX assisted squats for four 4-minute intervals at an intensity of 90-95% maximum heart rate, and the MIIT group performing TRX assisted squats for four 4-minute intervals at 70% of max heart rate (the control group continued their daily lifestyle activities).

What were the findings? Over the course of 12 weeks, there were significant changes in both the HIIT and MIIT groups regarding both improved sleep quality and decreased fatigue, with the HIIT group showing markedly better results (the MIIT group showed no difference from

the control group in terms of fatigue). The authors reported that both groups tolerated the suspension training program well, and that compliance was excellent.

Possible limitations of this study include: a 12-week intervention may not have been long enough to see significant results in the MIIT group, sleep quality was self-reported, and the description of the TRX assisted squat exercise performed during the intervals was insufficient. The authors described the squat as beginning in a "crouched position"; does this mean that deep knee flexion (< 90°) was performed with each repetition? If so, over time the selected exercise protocol may be problematic for older adults with knee osteoarthritis or knee replacements.

Nevertheless, improved sleep quality and decreased fatigue as a result of performing a HIIT non-impact activity using a suspension training system is a positive outcome.

Key Points from a Review on Aquatic HIIT

Since this is a themed issue for our journal, and the theme is high-intensity interval training (HIIT), I am gearing this particular column to research findings on low- or non-impact HIIT alternatives. As such, I would be remiss if I didn't address aquatic exercise and HIIT. I am choosing to provide a quick "research bite" reminder as I profile an excellent review paper authored by Nagle, Sanders, and Franklin in 2016 (4), and subsequently modified for this journal in a 2019 article (5).

The purpose of the review, as stated by the authors, is to examine the role of aquatic exercise as an alternative safe and effective HIIT modality. Aquatic exercise, performed primarily in an upright position in relatively shallow water, has been widely studied in clinical populations and has been shown to be a safe and low weight-bearing modality, yielding multiple benefits. After describing the effects of buoyancy, hydrostatic pressure, viscosity, and thermodynamics on the body during upright water immersion, Nagle et al identify benefits of HIIT programs when compared to continuous-intensity aquatic protocols, based on a review of the literature. The authors state that, "an important and often overlooked benefit of aquatic HIIT is the opportunity to achieve higher intensities along with a reduction in force and joint compression that occurs compared with traditional land-based exercise." As such, aquatic HIIT may be the perfect modality for elderly and obese populations, and for those with musculoskeletal issues including osteoarthritis and fibromyalgia, especially when compared with traditional land-based HIIT programs.

In the review article, research on the cardiometabolic adaptations to HIIT during swimming versus upright aquatic exercise is discussed, in addition to aquatic exercise program design. The S.W.E.A.T. method, developed by WaterFit, is of particular note, as it combines six basic movement patterns (walking, jogging, kicking, jumping, rocking, and scissors) performed as intervals. Exercisers can regulate intensity by changing the speed of various movements, vertical lifting and lowering in the water, changing the range of motion, changing the place of action, and/or traveling through the water, among other variables. The S.W.E.A.T. system thus provides hundreds of exercise options for variety and intensity. An example of a recommended interval sequence: 15 seconds moderate intensity, 15 seconds hard intensity, 15 seconds easy—repeat using different movement variations or different basic moves. This HIIT design is time-efficient and appears to maintain participant interest, enthusiasm, and adherence.

In summary, aquatic HIIT yields many benefits, much like land-based HIIT. Notably though, aquatic HIIT results in substantially less stress to joints, and thereby offers an important exercise modality for injured athletes, those struggling with osteoarthritis or other musculoskeletal pain, the elderly, and people challenged by obesity.

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