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Reduced Modulation of Pain in Older Adults After Isometric and Aerobic Exercise

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Abstract: **Laboratory-based studies show that acute aerobic and isometric exercise reduces sensitivity to painful stimuli in young healthy individuals, indicative of a hypoalgesic response. However, little is known regarding the effect of aging on exercise-induced hypoalgesia (EIH). The purpose of this study was to examine age differences in EIH after submaximal isometric exercise and moderate and vigorous aerobic exercise. Healthy older and younger adults completed 1 training session and 4 testing sessions consisting of a submaximal isometric handgrip exercise, vigorous or moderate intensity stationary cycling, or quiet rest (control). The following measures were taken before and after exercise/quiet rest: 1) pressure pain thresholds, 2) suprathreshold pressure pain ratings, 3) pain ratings during 30 seconds of prolonged noxious heat stimulation, and 4) temporal summation of heat pain. The results revealed age differences in EIH after isometric and aerobic exercise, with younger adults experiencing greater EIH compared with older adults. The age differences in EIH varied across pain induction techniques and exercise type. These results provide evidence for abnormal pain modulation after acute exercise in older adults.**

Perspective: ***This article enhances our understanding of the influence of a single bout of exercise on pain sensitivity and perception in healthy older compared with younger adults. This knowledge could help clinicians optimize exercise as a method of pain management.***

Key words: *Exercise-induced hypoalgesia, aging, pain modulation, acute exercise, exercise analgesia.*

The burden of chronic pain among older adults is substantial, with up to 60% of older adults in large community-based samples reporting chronic pain.[34,40] Pain is one of the primary causes of physical disability,[17] significantly affects quality of life,[39] and dramatically increases individual and national health care costs.[8] Substantial evidence supports the use of exercise as an effective tool to reduce pain, and it is often recommended as an adjunct therapy in the treatment of chronic pain.[7,13,14,19,45] Evidence from clinical trials suggests that regular exercise can reduce pain symptoms in chronic pain conditions affecting older adults.[7,19,45] In addition, a single bout of exercise influences the experience of pain. In healthy young adults, acute aerobic and isometric exercise temporarily reduces pain sensitivity, a phenomenon termed exercise-induced hypoalgesia (EIH).[30] However, many individuals with chronic pain (ie, fibromyalgia, neuropathic pain) do not experience EIH, and pain sensitivity and perception are often temporarily exacerbated after acute exercise.[16,20,23,44,47] As regular exercise becomes an important component of the multidisciplinary treatment recommended for persistent pain in older adults, a comprehensive understanding of how acute exercise influences pain perception in this age group is important to optimize exercise as a method of pain management.

The experience of pain is modulated by complex endogenous systems that both facilitate and inhibit pain.[43] Substantial evidence from psychophysical tests (ie, condition pain modulation [CPM], offset analgesia) indicates that dysfunction of pain inhibitory systems increases with age.[5,24,28,38] A recent study revealed that endogenous pain inhibitory capacity, as shown on the CPM test, predicted the magnitude of pain reduction after acute isometric exercise.[26] Thus, participants who had a poor pain inhibitory capacity were more likely to experience a hyperalgesic response after isometric

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exercise. Despite this evidence, little research has explored changes in pain sensitivity and perception after acute exercise in healthy older adults, a cohort who typically show poor pain inhibitory capacity. One of the only studies to address this topic[25] investigated the effect of isometric contractions that varied in intensity and duration on pressure pain perception in older and younger adults. Both older and younger adults showed reductions in pain after the isometric contractions; however, the EIH effect was smaller in older adults. To the best of our knowledge, no studies have examined EIH after aerobic exercise in older adults.

The primary purpose of the current study was to examine age differences in EIH after submaximal isometric exercise and moderate and vigorous aerobic exercise. Several studies have shown that experimental pain measures correlate only moderately across stimulus modalities and tests[11,33]; thus, we tested for EIH using a multimodal pain assessment. We assessed changes in threshold and suprathreshold pressure pain, temporal summation (TS) of pain, and pain perception during a prolonged heat pain test before and immediately after exercise. These pain measures likely represent distinct dimensions of pain perception that may be under the influence of different mechanisms.[11] We hypothesized that EIH would be reduced in older compared with younger adults across all forms of acute exercise and pain tests.

Methods

Participants

Participants were 25 (age range, 19–30 years; average age, 21.7 ± 4.1 years; 14 females) healthy young adults and 18 (age range, 55–74 years; average age, 63.7 ± 6.6 years; 9 females) older adults. Studies show that adults 55 years and older have reduced capacity for pain inhibition[29,38]; therefore, we included adults 55 years and older in our older adult group. The younger group included 16 whites, 3 Asian Americans, and 6 Hispanic Americans. The older group included 15 whites, 1 Asian American, and 2 Hispanic Americans. Detailed results of the data on the younger adults have been published previously.[31,32] A power analysis using G Power 3.1.5 (Heinrich Heine University, Dusseldorf Germany) was used to estimate the sample size needed for detecting a session by age group interaction for the outcome measures in a mixed model design. With the significance level set at .05, power at .80, a .5 correlation among repeated measures, and the effect size (ES) for differences between groups estimated to be moderate, the power analyses determined that a total of 34 participants (17 per group) would yield a power of .81.

Participants were recruited through posted advertisements in the local community. Exclusion criteria included: 1) current use of narcotics or tobacco products, 2) uncontrolled hypertension, 3) neurologic disease with significant changes in somatosensory and pain perception at intended stimulation sites, 4) the known presence of or any signs or symptoms of cardiovascular disease, pulmonary disease, or metabolic disease, 5) serious psychiatric conditions (eg, schizophrenia and bipolar disorder), and 6) current use of opioids. Younger adults were excluded if they were not physically ready to exercise without a medical examination as indicated by the Physical Activity Readiness Questionnaire (PAR-Q).[41] Older adults had to obtain physician approval from their primary care physician to participate in the study. During the health history interview, no participants indicated that they were regularly taking pain medications or reported chronic pain. Session exclusion criteria included active infectious disease or febrile condition (eg, sinusitis, influenza), severe uncontrolled hypertension, use of caffeinated drinks, or any pain medications before the experimental sessions.

Procedures

The university institutional review board (IRB) approved all procedures, and participants signed an IRB-approved informed consent form. Participants completed a screening/training session followed by 4 randomized experimental sessions. All sessions were separated by a minimum of 48 hours and conducted at approximately the same time of day (±2 hours). All sessions began after 2 stable blood pressure readings separated by 5 minutes.

Screening and Training Session

To determine eligibility, participants completed the PAR-Q, a health history questionnaire, supplemented by clarification by interview, height and weight measurement, and a resting heart rate (HR) and blood pressure measurement. Older adults were also given a letter that had to be signed by a physician, which granted the participant medical clearance to participate in the study. The experimental sessions were not scheduled until medical clearance had been obtained. Once eligibility was determined, participants completed a training session designed to 1) teach them the continuous pain rating system and 2) determine the individualized temperatures of the thermal stimuli for the heat pain testing protocols such that participants would experience moderate pain (ie, 50/100 on a 0–100 visual analog scale). For this purpose, trains of increasing heat stimuli were applied to the forearm until participants experienced a moderate level of pain (40–60 on a 0–100 visual analog scale). In addition, the experimental pain testing procedures were conducted once during the training session to ensure familiarity with the testing protocols. During this session, participants also completed the International Physical Activity Questionnaire, which assesses the amount of time during the previous week spent on vigorous activity, moderate activity, and walking.[4]

During the training session, maximal voluntary contraction (MVC) of handgrip muscles was also determined using a hand dynamometer (Jamar Hydraulic Hand Dynamometer; Patterson Medical, Warrenville, IL). The dynamometer handle was adjusted according to manufacturer guidelines for each participant. Participants placed their dominant arm on a table surface with