Effects of Ibuprofen Topical Gel on Muscle Soreness

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ABSTRACT

HYLDAHL, R. D., J. KEADLE, P. A. ROUZIER, D. PEARL, and P. M. CLARKSON. Effects of Ibuprofen Topical Gel on Muscle Soreness. Med. Sci. Sports Exerc., Vol. 42, No. 3, pp. 614–621, 2010. Purpose: Muscle soreness is a common symptom after novel exercise and may influence exercise adherence. This study examined the effect of an ibuprofen topical gel and the effect of age and sex on muscle soreness after a gym exercise. Methods: One hundred and six participants completed six sets of 10 repetitions of the elbow and knee flexor muscles. Thirty-six hours after exercise, participants were randomized to apply an ibuprofen topical gel or placebo treatment to the affected muscle groups. Soreness evaluations were taken each hour for the first 6 h (36–42 h), then at 48, 60, 66, 72, 84, 90, 96, and 108 h after exercise. Subjects then returned to the laboratory after 3 wk and repeated the same study protocol with the opposite arm/leg and treatment. Results: We found no significant differences in soreness between the active ibuprofen gel and the placebo treatment and no difference in effectiveness between men and women or between older and younger subjects. For the placebo groups, there was no sex differences in muscle soreness; however, when the data were analyzed by dividing participants into young (18–29 yr) and old (40–65 yr) cohort, the old cohort reported significantly less soreness in response to the elbow flexion exercise than the young cohort (P < 0.01). Conclusion: The results of this study suggest that the topical application of ibuprofen is not an effective treatment for muscle soreness after an unaccustomed gym exercise. Furthermore, our results show that there is no sex difference in the soreness response and that older subjects have less soreness in response to a similar exercise stimulus as younger subjects. Key Words: MUSCLE PAIN, NSAID, RESISTANCE EXERCISE, DOMS

Unaccustomed exercise, particularly eccentric exercise, typically results in muscle soreness. The time course of muscle soreness after unaccustomed exercise has been well documented (5). Studies show that it peaks between 24 and 48 h after exercise and subsides within 5–7 d (6,10). Although muscle soreness is generally regarded as a benign and a self-resolving side effect of a novel exercise, it may result in the discontinuation of exercise participation, thus reducing adherence and subsequent health benefits.

Several treatment strategies have been investigated for their efficacy in alleviating muscle soreness. These have included cryotherapy (3), massage (33), ultrasound (3), and nonsteroidal anti-inflammatory drugs (9,15). Because inflammation is regarded as a contributor to the postexercise muscle soreness response, nonsteroidal anti-inflammatory drugs have been targeted for their possible therapeutic effects (2) and are also commonly used to alleviate pain after soft tissue injury. Currently, the most common form of NSAID administration is oral. Such administration, however, is associated with gastrointestinal side effects (17). Moreover, the incidence of serious and/or fatal adverse drug reactions has been shown to be a significant health risk (21) and tends to increase with polypharmacy (the simultaneous administration of multiple drugs), especially in the elderly (23). A strategy to minimize unwanted adverse effects has been the development of topical preparations. In human trials, topical application of nonsteroidal anti-inflammatory drugs has been shown to produce analgesia of both cutaneous and muscle pain (1,22,34). Furthermore, Tegeder et al. (36) reported that levels of topically applied nonsteroidal anti-inflammatory drugs were found in the muscle at similar concentrations to those that were systemically delivered.

It has been reported that approximately 40% of individuals older than 65 yr fill an NSAID prescription each year, making it one of the most commonly prescribed medications for older adults in the United States (8). In light of a growing elderly population and the associated incidence of adverse events with NSAID use, it is important to evaluate the effectiveness of nonsystemic, topical NSAID delivery in older populations. It has also been suggested that women have a greater incidence of adverse NSAID associated
gastric events than men (31). Thus, we were interested in determining the effects of both age and sex on muscle soreness in response to the topically applied ibuprofen gel.

The effectiveness of nonsteroidal anti-inflammatory drugs as a treatment for exercise-induced muscle soreness has not been entirely resolved. For example, Hasson et al. (16) demonstrated that oral ibuprofen administration, taken both prophylactically and 24 h after eccentric exercise of the knee extensors, significantly reduced muscle soreness. Furthermore, both oral and transdermal ketoprofen, an NSAID often prescribed for osteoarthritis pain, have been shown to attenuate eccentric exercise-induced muscle soreness of the elbow flexors and knee extensors, respectively (1,30). Several investigators, however, have reported no effect of oral NSAID administration on muscle soreness after eccentric exercise (9,15). Thus, it remains uncertain the extent to which nonsteroidal anti-inflammatory drugs are effective in the treatment of muscle soreness. It must be noted that these studies have all relied on specific damage-inducing protocols involving maximal eccentric contractions. Such contractions are known to generate a large degree of soreness that results from considerable muscle damage rather than a more mild form of soreness/damage produced after a workout session in a gym or health club setting performed by a beginner.

Therefore, the purpose of this report was to examine the effects of a topical analgesic preparation on muscle soreness after an unaccustomed gym exercise. We hypothesized that the topical NSAID treatment would result in a reduction of peak muscle soreness compared with the placebo condition. We were also interested in evaluating differences in the soreness response between men and women and between older and younger individuals. To our knowledge, this is the first study to report these effects in a large population of both older and younger men and women after what could be considered an exercise strategy used in a health club or gym setting. Therefore, the results reported here may be of significant clinical value for both the prescription of exercise and the treatment of exercise-related muscle soreness.

MATERIALS AND METHODS

This study used a resistance exercise strategy that could be done in a gym or health club setting to evaluate the efficacy of a topical ibuprofen on muscle pain and soreness. The topical analgesic consisted of a 10% ibuprofen concentration. This concentration is consistent with the upper limit of what is currently available on the market in the United Kingdom. A written informed consent, approved by the human subjects review committee at the University of Massachusetts Amherst, was obtained from each study participant. There were 106 subjects, ages 18–65 yr, enrolled in the doubly blinded, randomized, crossover study.

Study schedule. The study consisted of 11 visits, separated into two periods (period 1 = visits 2–6; period 2 = visits 7–11) over the course of 5 wk. At visit 1, written informed consent, Physical Activity Readiness Questionnaire, anthropometric measurements, inclusion/exclusion criteria, pregnancy test (for all women of child bearing potential), and physical examination (if applicable) were obtained. Visit 2 consisted of baseline soreness evaluations using a visual analog scale (VAS) to assess soreness on the back of the thigh and upper arm before the weight lifting exercise portion of the study. Only two predetermined randomized sides of the body (one arm and one leg) were exercised. Also during visit 2, study participants were assigned a subject number and randomized into placebo or active drug groups such that half of the subjects received the active drug and half received the placebo treatment during the first period of testing. Subjects were further randomized into dominant or nondominant side exercise and treatment. All randomizations were reversed during the second period of the study. Visit 3 occurred 36 h (∓ 2 h) after the exercise. This time point was chosen because previous work in our laboratory has indicated that most subjects experience peak soreness at 36 h after exercise. Pretreatment soreness was measured, and study drug was administered (either an ibuprofen gel or a placebo gel). Subjects remained in the laboratory for the following 6 h where soreness assessments were taken every hour. Visits 4, 5, and 6 occurred at 60, 84, and 108 h after visit 2, respectively. At these visits, soreness assessment and drug administration were performed and recorded. After a drug-free interval of no shorter than 3 wk, the subject returned to the laboratory for period 2 (visits 7–11). The same protocol used in visits 2–6 was repeated for visits 7–11 using the opposite arm and leg involved in period 1. The opposite gel dose was also administered.

Subject inclusion and exclusion criteria. Subjects were telephone screened and given a screening number if they met minimum qualifications. During the investigative periods of the study (visits 3–6 in period 1 and visits 8–11 in period 2), subjects agreed to refrain from the use of other analgesics, other muscle therapy treatments, strenuous or new physical activity, and alcohol use; caffeine use was prohibited for at least 3 h before data collection, including the entire duration of the 6-h soreness assessment that occurred 36 h after exercise at visits 3 and 8. All subjects were required to complete a Physical Activity Readiness Questionnaire and voluntarily answer “no” to all questions. Exclusion criteria included occupations that required heavy lifting or strenuous activity or participation in weight or resistance training programs for the past 6 months; subjects that self-reported physical activity levels higher than 6 METs were excluded. No recent participation in other clinical trials testing unapproved drugs, use of any medications that would have interfered with study results, use of dietary supplements (other than vitamins and minerals ≤100% RDA) such as protein supplement for increasing muscle mass or weight gain, or supplements that contained stimulants such as ephedra were permitted. Acceptable study participants should not be pregnant or
The one-repetition maximum tests. The one-repetition maximum (IRM) elbow flexion test was performed on a seated preacher curl bench with underarm supports that held the subject’s upper arm at an angle of approximately 45°. The test was conducted with the arm at rest with the elbow in a flexed position of approximately 115°. The subject was instructed to extend the forearm down to approximately 5° above full elbow extension and then return the arm to the original starting position. The IRM knee flexion test was performed on a leg curl bench with the subject laying face down. The test began with the knee at approximately 0° of flexion. The subject was instructed to pull the weight up toward themselves as far as their individual range of motion (ROM) would allow. To warm up, eight repetitions at 40% and four repetitions at 60% of an estimated IRM was performed by the subject for each elbow and knee flexion exercise, respectively. In period 1, the weight used for the estimated IRM was initially determined on the basis of body weight to provide a starting point from which an empirical determination of actual IRM could be made. During period 2, the IRM of the previously exercised side was used as the IRM estimate. A 2-min rest was given between each warm-up exercise. Upon completion of the warm-up sets, IRM trials were performed at 3-min intervals until the subject failed to successfully complete the repetition for the specific exercise. If the subject successfully lifted the IRM estimated weight, the investigator added weight in either 1.13- or 2.26-kg increments depending on the effort reported by the subject until failure was achieved. One-repetition maximum was considered the greatest amount of weight that the subject could successfully lift without assistance. No subject required more than four repetitions to determine IRM.

Exercise. Subjects performed six sets of 10 submaximal repetitions of the elbow and knee muscle flexor groups of the randomized side. The repetitions were completed by lifting a weight equal to 80% of the subject’s 1RM. Each set was separated by a 3-min rest period, and each repetition was done by the subject at a self-selected pace. Elbow flexor exercises began with the arm at rest and the elbow in a flexed position of approximately 115°. The subject was instructed (and verbally encouraged throughout the exercise) to extend the forearm down (while holding the weight) to approximately 5° above full elbow extension and then return the arm to the original starting position while staying in the same plane throughout the ROM for the completion of one repetition. Knee flexor exercises were conducted on a standard hamstring curl bench and began with the knee at approximately 0° of flexion. The subject was positioned in a prone position with the leg resting under a padded portion of the lever arm that carried the weight. Subjects were instructed to pull the weight up toward themselves as far as their individual ROM would allow and then slowly lower the weight back to the original starting position for the completion of one repetition. Subjects were also verbally encouraged to provide their maximal effort during the entire exercise session. During the submaximal exercise sets for both arm and leg flexor groups, if the subject could not finish a repetition within the set, a study investigator would provide the minimum amount of aid to the subject until the completion of the set; the number of repetitions completed (unaided and aided) was then recorded. Subjects were permitted to fail (when investigator would provide assistance) on up to six repetitions before the submaximal repetition weight was lowered by 1.1 kg. Weight was continually lowered in increments of 1.136 kg if subject continued to fail six or more repetitions until completion of the exercise session occurred.

Soreness assessment. Baseline pain/soreness was assessed on the front of the upper arm and on the back of the thigh of the assigned exercise side using a VAS before the start of the exercise session. Subjects were instructed to make a single vertical mark on the VAS that corresponded to their pain levels. They were instructed that a mark on the far left (0 mm) of the scale would indicate no pain whereas a mark on the far right (100 mm) would indicate “the worst pain imaginable.” Marks were then measured using a Fisher scientific ruler.

To ascertain the acute effects of the ibuprofen gel, pain and soreness levels were assessed for six continuous hours at 36 ± 2 h from the time of exercise completion and at 37, 38, 39, 40, 41, and 42 h after exercise and then at 48-, 60-, 66-, 72-, 84-, 90-, 96-, and 108-h time markers. At each of these soreness evaluations, the subject would complete two full ROM bicep and leg curls while holding a 0.45-kg dumbbell or lifting a 2.27-kg ankle weight (subject’s bodyweight ≤ 54.5 kg) or a 0.9-kg dumbbell and a 4.54-kg ankle weight (subject’s bodyweight > 54.5 kg), respectively. Immediately after completing each soreness assessment task, exercise subjects were instructed to rate their pain by marking the VAS.

After the first pain assessment at 36 h after exercise, the investigators demonstrated and applied a topical ibuprofen or placebo gel to cover the entire treatment areas (~a 2-inch ribbon). A 2-inch ribbon of active drug gel contained approximately 125 mg of ibuprofen. The placebo gel was designed to maintain the same components of the active gel minus the active ibuprofen and thus was similar in consistency and appearance. Subjects remained in the laboratory for the following 6 h where pain assessments were taken hourly. At the end of the 6 h, subjects self-administered the
TABLE 1. Subject characteristics.

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<tr>
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<th>All Subjects</th>
<th>Old (n = 41)</th>
<th>Young (n = 52)</th>
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<tr>
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<td>Men (n = 41)</td>
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<td>Men (n = 23)</td>
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<td>Women (n = 29)</td>
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| Age (yr)            | 32.6 ± 13.4  | 37.3 ± 15.1  | 51.5 ± 6.9     | 52.7 ± 5.6     | 23.1 ± 3.4     | 22.4 ± 3.5     |
| Height (cm)         | 171.1 ± 19.7 | 164.1 ± 15.6 | 169.3 ± 10.2   | 164.7 ± 7.9    | 173.5 ± 10.6   | 164.8 ± 8.0†   |
| Weight (kg)         | 75.6 ± 17.3  | 70.3 ± 13.0  | 79.2 ± 19.2    | 74.4 ± 15.8    | 72.6 ± 17.2    | 66.9 ± 11.4*   |
| Body mass index     | 25.7 ± 6.1   | 26.2 ± 5.1   | 27.6 ± 9.4     | 27.4 ± 9.7     | 24.1 ± 3.5†    | 24.6 ± 4.0†    |
|                     |              |              |                |                |               |               |

Characteristics of all subjects, separated by men and women, and of age-partitioned subject cohort. Values are presented as mean ± SD.

* Significant (P < 0.05) difference between men and women.
† Significant (P < 0.05) difference between old and young subjects of the same sex.

gel under the supervision of study investigators. Subjects were given two tubes of topical gel and instructed to apply the gel at home 6 h from the end of the laboratory visit after completing self-administered soreness assessment on take-home VAS cards. Supervised pain assessments and gel applications occurred at 36 h (visit 3), 42 h (visit 3), 60 h (visit 4), 84 h (visit 5), and 108 h (no gel application at 108 h, visit 6) after exercise. Unsupervised home pain assessments and gel applications using a diary and VAS cards occurred at 48, 66, 72, 90, and 96 h after exercise. Before gel applications at laboratory visits, gel tubes were weighed in grams to measure gel usage as well as protocol compliance. Topical gel application was required only when pain/soreness was felt in the target areas. If there was no pain, no gel was applied. Upon completion of a 3-wk drug-free interval between visits 6 and 7, subjects returned to the laboratory and repeated the same study protocol using the opposite side that was originally tested. Two new gel tubes were dispensed that contained the counterpart to the original randomization of either active drug or placebo.

**Statistical analysis.** The mixed procedure for the Statistical Analysis System (SAS Institute, Cary, NC) was used for ANOVA to determine statistical differences in the data. Differences in descriptive data were determined by a one-way ANOVA. Dependent variables were assessed using a repeated-measures two-way ANOVA with the main effects being treatment (active gel vs placebo) and age (younger vs older) or treatment and sex (men vs women). A three-way ANOVA was used to test for significant differences among treatment, sex, and age. Where there were significant differences, a Tukey’s post hoc test was used for individual comparisons. A P value ≤ 0.05 was considered significant for all tests.

**RESULTS**

**Subject characteristics.** Presented in Table 1 are the age, height, weight, and body mass index for all subjects and by sex and age. All subjects (n = 106) were used in the analyses of the overall effect of the ibuprofen gel on muscle soreness and the effect of sex on muscle soreness. However, to ascertain age-related differences in muscle soreness, 93 of 106 subjects were used for the analyses. Thirteen subjects were aged 26–39 yr and were not included in this analysis. The determination of a “young” and an “older” cohort defined by ages of 19–25 and 40–65 yr, respectively, was made on the basis of data indicating differences in soreness response to an eccentric damaging protocol with similar age cohorts (19). Therefore, we were interested to see if similar differences in these age cohorts existed after an average gym exercise.

**1RM and exercise performance.** Figure 1 presents 1RM performance for the elbow and knee flexors in older and younger subjects. Subjects performed six sets of 10 repetitions at 80% of their 1RM. Thus, the amount of weight lifted (e.g., work performed) throughout the exercise session was dependent on the subject’s 1RM. For the elbow flexors, average 1RM was not significantly different between the young and the old age cohort. For the knee flexors, average 1RM was significantly higher in the young cohort compared with the old cohort. All subjects, both old and young, completed the six sets although the majority of subjects in both cohort groups required assistance, especially in the latter sets.

**Effect of topical ibuprofen.** Figure 2 presents data for the effect of topical gel application on muscle soreness for all subjects (n = 106). As expected, muscle soreness was at its highest observed level at 36 h after exercise in both the bicep and the hamstring and gradually returned to baseline levels over time. A repeated-measures ANOVA detected a significant difference for time (P < 0.01), although there were no differences in soreness reported in the 6 h after the first gel application (36–42 h). There were also no significant differences overall in muscle soreness between the active gel and the placebo treatment for both the bicep and the hamstring. Furthermore, there were no significant age or sex interaction effects.

**FIGURE 1—Average 1RM values for elbow (bicep) and knee (hamstring) flexor exercises in young and old age cohorts expressed as mean ± SEM. †Significant difference between young and old age cohorts (P < 0.05).**
Effect of age. The crossover study design allowed us to use all study participants in an analysis of muscle soreness while eliminating any possible effect of the drug. Thus, all subject data were evaluated in the placebo condition to ascertain the differences in muscle soreness between young and older aged cohorts. Figure 3 presents data on the differences in muscle soreness between the two age cohorts. For the bicep, a repeated-measures ANOVA detected differences between the two age cohorts ($P < 0.01$; Fig. 3). Post hoc testing showed significant differences at most time points. A within-subject analysis revealed significant differences for time ($P < 0.01$) but not for the time $\times$ age interaction. There were no significant differences between the two age cohorts for hamstring muscle soreness.

Effect of sex. Subject data were also evaluated in the placebo condition to examine the effects of sex on muscle soreness. A repeated-measures ANOVA detected a significant difference for time ($P < 0.01$). However, the ANOVA showed that there were no differences in reported muscle soreness between men and women for both the hamstring and the bicep (Fig. 4). The ANOVA detected no sex $\times$ age interaction effect, nor was there a significant sex $\times$ age $\times$ time interaction effect.

DISCUSSION

The response to unaccustomed exercise in humans typically results in muscle soreness. In some cases, muscle soreness symptoms can reduce the adherence and subsequent benefits associated with exercise. This study examined muscle soreness after an exercise of similar intensity to that performed in a health club setting and evaluated whether a topical ibuprofen gel would alleviate the soreness and whether age or sex influenced the responses.
The major finding of this study was that the topical application of an ibuprofen gel had no effect on muscle soreness. This was the case when all subject data were pooled and also when subject data were divided into young and old or by sex. Although the effects of nonsteroidal anti-inflammatory drugs on exercise-induced muscle soreness have been well studied, a general consensus on the efficacy of NSAID treatment has yet to be established. Data collected in our laboratory have suggested that oral ketoprofen, an NSAID that bears similar structural, anti-inflammatory, and analgesic properties to ibuprofen (24), significantly reduced perceived muscle soreness after eccentric exercise of the elbow flexors (30). Moreover, a topical ketoprofen treatment was found to reduce exercise-induced muscle soreness 48 h after exercise in a small cohort of young men (1). Donnelly et al. (9), on the contrary, reported no difference in muscle soreness between oral ibuprofen and placebo-treated groups after a downhill running protocol. Similarly, Stone et al. (35) found no differences in muscle soreness between oral ibuprofen and placebo treatment groups after an eccentric elbow flexor protocol. Our results confirm those findings that have shown no effect of orally administered nonsteroidal anti-inflammatory drugs on muscle soreness (9,15). Furthermore, we have demonstrated this in a large number of both men and women across a broad range of ages. However, to more fully elucidate the effectiveness of a topical ibuprofen gel among the elderly population—the population most likely to fill an NSAID prescription—additional studies will need to be done to include subjects older than 65 yr. It can also be noted that a topical application of ibuprofen appears to have essentially no effect on muscle soreness regardless of the peak level of soreness achieved. For example, our data show that the knee flexor exercise produced significantly lower soreness values than the elbow flexor exercise, yet the response to the topical ibuprofen was the same.

Timing of the ibuprofen dose may also significantly affect the alleviation of muscle soreness symptoms. For example, of the relatively few trials involving oral doses, those that gave prophylactic doses seem to have demonstrated greater reductions in muscle soreness symptoms (16,27). Under the notion that most people do not seek a soreness intervention until after the onset of symptoms, we chose to apply the ibuprofen gel 36 h after exercise, when soreness has been shown to peak. Future work will need to be undertaken to determine whether a prophylactic dose of topical ibuprofen is effective in alleviating exercise-induced muscle soreness symptoms.

In this study, there were no direct measurements to verify that the topically applied ibuprofen reached the target muscle. However, it has been demonstrated that topical NSAID applications result in muscle levels at least equivalent to those reached with systemic administration (36) and that they exceed threshold levels necessary for anti-inflammatory activity (13). Other studies have also reported significant analgesia with topical application of nonsteroidal anti-inflammatory drugs in human models of both cutaneous and muscle pain (22,34). Since 1980, when the topical NSAID benzydamine was first licensed in the United Kingdom (14), several European countries as well as Japan and South Africa have even made topical NSAID preparations available over the counter.

The second major finding of the study was that older individuals reported less soreness in the biceps than younger individuals. It has been previously reported that older individuals may be more susceptible to exercise-induced muscle damage (4,26) and hence report greater soreness values in response to novel exercise. On the contrary, two recent studies by Lavender and Nosaka (19,20) present compelling evidence that older individuals consistently show lower muscle soreness values in response to eccentric exercise. They reported significant differences in soreness of the elbow flexors between a young aged cohort (mean age = 19.4 yr) and both a middle aged cohort (mean age = 48 yr) (20) and an old aged cohort (mean age = 70 yr) (19). Using a larger number of subjects, we similarly show significantly lower soreness values in the elbow flexors of older compared with younger subjects. Moreover, we have shown that this is the case after a gym exercise session involving both concentric and eccentric loads whereas the previous reports used solely eccentric contractions of the elbow flexors to induce significant muscle damage. Such contractions, although effective for producing muscle damage for the purpose of studying responses, may not represent the normal exercise experience by free-living individuals. Interestingly, this same effect was not seen for the knee flexors. This could potentially be attributed to the fact that the younger group, on average, lifted more weight than the older group, perhaps resulting in greater damage and thus more soreness. It may also indicate that the effect could be muscle specific. However, more research is needed to conclude this as other reports showing a similar reduced soreness response in older subjects have only tested the elbow flexor muscles (19) and not the knee flexors as we have done here. Another likely explanation could be that this effect is only observed at higher soreness levels. At 36 h after exercise, young subjects in this study reported 66% lower soreness in the knee flexors than the elbow flexors. Likewise, older subjects reported 42% lower soreness in the knee flexors (Fig. 3). Perhaps the perception of muscle soreness must first reach a critical threshold to see the age-related differences as we did for the elbow flexors. It must be noted also that for the knee flexors, the old cohort had a significantly lower 1RM and thus lifted less weight through the six sets of exercise on average, possibly resulting in less muscle damage and accompanying soreness.

The crossover study design allowed us to further confirm the age-related reductions in muscle soreness. Because the ibuprofen gel had no effect on reported muscle soreness at any time point, we were also able to analyze the data for age-related differences in the arm that was exercised and then exposed to the ibuprofen gel. Under this condition, we also discovered that older individuals reported significantly lower levels of pain in the elbow flexors than younger individuals.
men (19–25 yr.) soreness in response to eccentric exercise despite no difference in pain thresholds in response to palpation of pericranial muscles. Although findings regarding age-related differences in pain perception have been somewhat mixed, many have argued that the preponderance of evidence supports the idea that there is an age-related decline in pain sensitivity (11,12). This idea is further supported by Lavender and Nosaka (19) who found that older men (41–57 yr) reported less muscle soreness in response to eccentric exercise despite no differences in markers of muscle damage compared with younger men (19–25 yr.)

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