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# THE EFFECTS OF IBUPROFEN ON MUSCLE PERFORMANCE, WORKLOAD AND PLASMA CREATINE KINASE DURING A STRENGTH TRAINING SESSION

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## Abstract

**Introduction:** Non-steroidal anti-inflammatory drugs are the most often used substances by athletes.

**Objective:** To determine the effect of non-steroidal anti-inflammatory drug ibuprofen administration before a resistance exercise bout in the total training volume performed as well as in the acute plasmatic levels of creatine kinase.

**Methods:** Twelve strength-trained males (22.8 ± 3.2 years) performed a strength training bout twice: taking 1.2 g of ibuprofen and placebo one hour before the exercise session. Blood levels of creatine kinase (CK) were measured at four times: before ($CK_{pre}$), immediately after ($CK_{post}$), and 24h ($CK_{24}$) and 48h ($CK_{48}$) after the strength training sessions. In addition, the total volume performed was evaluated to verify possible differences in the training performance.

**Results:** There was no significant difference between the use of ibuprofen or placebo in total strength training volume. Furthermore, no differences were observed between ibuprofen or placebo condition in the $CK_{pre}$ (18.7 ± 8.6 vs. 15.3 ± 3.5), $CK_{post}$ (37.9 ± 19.6 vs. 32.1 ± 16.7), $CK_{24}$ (16.4 ± 6.4 vs. 16.9 ± 7.0) and $CK_{48}$ (12.8 ± 4.5 vs. 12.0 ± 5.0) ($P > 0.05$). There was a significant increase in the CK immediately after ($CK_{post}$), as well 48 hours after ($CK_{48}$) in both exercise conditions (placebo and ibuprofen) ($P = 0.002$).

**Conclusion:** The use of ibuprofen does not affect the total strength training volume in a single exercise bout, as well as has no effect in the acute CK responses to this exercise bout.

***Key words:*** *ibuprofen, creatine kinase, strength training, performance*

## Introduction

In an attempt to enhance athletes' performance, non-opioid painkillers have been indiscriminately used in the athletic community [1-7], and non-steroidal anti-inflammatory drugs are the most often used substances by these athletes [2,8].

Non-steroidal anti-inflammatory drugs (NSAIDs), which include Ibuprofen [9,10], have anti-inflammatory, analgesic, antipyretic and anti-thrombotic properties. The dynamics of these substances centers around the inhibition of activity of constitutive enzyme cyclooxygenase (COX-1, present in several human tissues) and inductive cyclooxygenase (COX-2, synthesized in inflammation sites) [11]. Considered as non-banned substances by the World Antidoping Agency (WADA) [4], NSAIDs are clinically used to reduce inflammatory symptoms and the time before athletes can resume their athletic activities [12].

Some studies have analyzed the effect of prophylactic administration of NSAIDs on performance in endurance tests [13,14], but no consensus was reached on the actual ergogenic power of these agents [4,15]. Furthermore, studies of the use of ibuprofen in anaerobic modalities, such as strength training, are scarce. In the randomized controlled clinical trial by Soltow et al. [16], who investigated the effects of chronic use of ibuprofen on the hypertrophic response of rats submitted to 14 days of chronic overload, it was observed a significant reduction in protein synthesis in the experimental group, suggesting a negative effect of the drug administration. On the other hand, Krentz et al. [7], investigating non-trained young males submitted to a six-week training program of strength training, have found no effect of ibuprofen on the hypertrophic response among the trained subjects. Recently, Trappe et al. [17] found that ibuprofen administration enhanced muscle strength and muscle size during a strength training program in older adults. In other study, Peterson et al. [18] assessed the effects of ibuprofen ingestion on the adaptations induced by 12 week of strength training program in patients with knee osteoarthritis. These authors have observed no effect of ibuprofen to justify the use of this NSAIDs together with the strength training in these patients. However,

these studies only assessed the protein synthesis as well as the hypertrophic responses in the muscle and the mechanical capacity of the muscles during a strength training session has not been investigated.

At the best of the authors' knowledge, no study has investigated the effect of a single dose of prophylactic Ibuprofen on the quantity of mechanical muscle performance reached during a strength training session, as well as the resulting muscle-skeletal repercussion. It is believed that increasing the acute quantity of exercise could induce catabolism, damage, and muscle pain [19,20], generating a decrease in performance in high volume strength training [21]. Thus, this study was designed to investigate the effects of Ibuprofen administration on the total training volume performed and the extent of muscle lesion resulting from a session of high volume strength training.

## Materials and methods

### *Participants*

Twelve males volunteered to participate in the study. They had at least one year of strength training and 1RM ≥ body weight in the bench press and squat exercises [1]. All subjects presented negative answers to the questions in the "Physical Activity Readiness Questionnaire" (PAR-Q) [22]. This study was approved by the Ethical Research Committee of the Federal University of Rio Grande do Sul. All participants signed an informed consent form before participation. Table 1 shows the physical characteristics of the sample.

Table 1. *Physical characteristics*

| | Mean ± SD |
|---|---|
| Age (years) | 22.8 ± 3.2 |
| Height (cm) | 177 ± 7.6 |
| Body mass (kg) | 78.6 ± 4.4 |
| % Fat mass | 18.5 ± 1.7 |
| % Lean mass | 82.6 ± 5.6 |
| ∑ Skinfolds (1)[37] | 163 ± 30 |

Values are mean ± SD; % percent; ∑, sum. Skinfolds sites: Triceps, chest, abdominal, pelvic, thigh, subscapular, and axillary.

### *Maximum dynamic force (1RM)*

The 1RM test is characterized by the greatest load that can be tolerated in repeating a particular exercise. Here the 1RM test was performed in the bench press and squat exercises. In the 48h preceding the test the subjects did not practice any kind of physical activity [1]. The equipment used for the test was the bench press and the squat cage with free weights of the make WORLD-ESCULPTOR (Brazil), with resolution of 1kg. Through trial and error, the 1RM value was determined in at most five attempts, with a five-minute interval between each. To control the movement speed during the test, a metronome (QUARTZ) with resolution of 1Hz was used, and in each attempt the concentric and eccentric phases lasted 2s [24].

### *Ibuprofen administration*

One hour before the strength training session the pharmacological treatment was started. It consisted in administering a single oral dose of Ibuprofen (1.2g) or placebo (microcrystalline cellulose) (randomly) in capsules that had the same weight, color, shape, odor, look and taste as the ibuprofen [15,25]. The treatment was randomized to research team members who were specially assigned to this role (double-blind). The participants were told to fast for one hour before the treatment to ensure gastric emptying.

### *Creatine Kinase Assay*

Blood samples were collected immediately before and after the strength training sessions and 24 and 48 hours after them to determine creatine kinase concentration [CK] plasma levels [16]. For CK analysis, we used the optimized kinetic UV method (IFCC) for determination in plasma in the CR-NAC system: unitest y AA (WIENER laboratory Rosário, Argentina). After collection, the blood samples were kept at room temperature for 45 minutes and centrifuged at 2.000 rpm, for 10 minutes to separate the serum, and then refrigerated at –20°C for later analysis [16,26] and 10% CV for each of the two assays.

### *Strength Training Protocol*

The strength training sessions were held with a week of interval from each other and consisted of six series of maximum repetitions in the bench press and squat exercises, recording the valid repetitions in two situations: with previous administration of Ibuprofen or placebo (crossover, randomized, double-blind clinical trial). The subjects started the strength training session with a warm-up in the cycloergometer for five minutes, followed by flexibility exercises for higher and lower limbs. After that, they performed six series of bench press and squat exercises without help, with a 65% 1RM load and 45s of interval between each series. The bench press exercise started from lying in dorsal decubitus with total stretch of the elbow (180°); the movement consisted in bending this joint to 90° (with horizontal stretch of the shoulder), returning to the initial position of the elbow at 180°. The squat exercise started from a standing position with the knees stretched to 180°, bending them to 90° and then returning to the initial position.

### *Statistical analysis*

Descriptive statistical analysis with mean, standard deviation, confidence interval for mean were performed. Furthermore, the Shapiro-Wilk normality

test was used. Two-factor ANOVA with repeated measures (use of drug vs. time) was used for evaluated the creatine kinase response. In addition, paired student's t-test was used to compare the total number of repetitions per sets. The level of significance considered in all analysis was $P < 0.05$.

## Results

### *Performance in bench press and squat on strength training session (SST)*

There were no significant differences between both strength training sessions (ibuprofen and placebo situation) in the total numbers of repetitions in bench press (Fig. 1) and squat (Fig. 2). In addition, there was no significant difference between situations (ibuprofen and placebo situation) in the total volume of training (Fig. 3). The effect size values for placebo situation were 0.93 for bench press and 0.96 for squat; and, for ibuprofen situation were 0.93 for bench press and 0.95 for squat.

### *Creatine kinase concentration on situations placebo and ibuprofen*

There was no statistically significant difference in creatine kinase concentration between placebo and ibuprofen conditions ($P > 0.05$). The value of the effect size for placebo situation was 0.93 and for ibuprofen was 0.88. In the both conditions (ibuprofen and placebo), there were a increases in the [CK] measured immediately after strength training session and 48hrs after exercise ($P = 0.002$) (Fig. 4).

## Discussion

The primary results of the present study showed that the administration of ibuprofen does not result in any improvement in the total volume of training during a strength training bout. Moreover, no differences between the different exercise conditions (ibuprofen and placebo) were observed in the serum levels of creatine kinase and both resulted in acute increase in the CK concentrations.

Anti-inflammatory drugs and opioid agents are among the most frequently used drugs in the treatment of acute muscle pain by nociception [27]. Among these NSAIDs, ibuprofen use has been widely investigated in aerobic activities such as ultramarathons [15], ironman and several Olympic modalities [12,25]. Studies investigating the action of 1.2 grams of ibuprofen in ultramarathons failed to find any difference in performance and creatine kinase concentration between individuals using this drug and those using placebo [15,28]. Although the above-mentioned studies were done in aerobic activity, they corroborate the results of the present study as no improvement in performance was detected in the investigated tests. In investigating eccentric muscle strength, Kraemer et al. [8], investi-

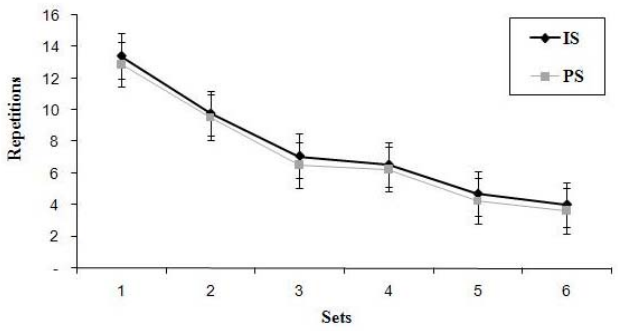


Fig. 1. *Result from the bench press exercise at the placebo situation (PS) and Ibuprofen situation (IS); values appear as mean ± SD from total repetitions in each set*

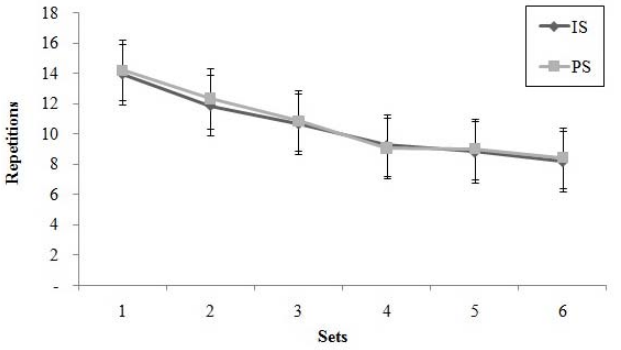


Fig. 2. *Result from the squat exercise at the placebo situation (PS) and Ibuprofen situation (IS); values appear as mean ± SD from total repetitions in each set*

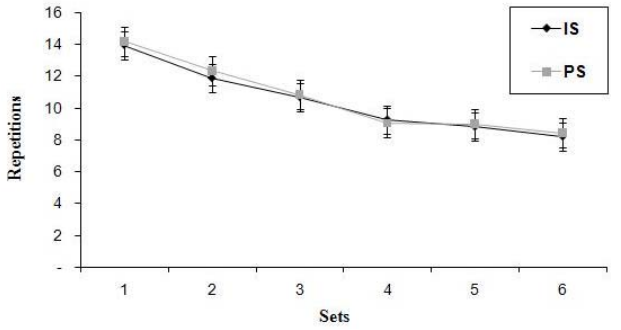


Fig. 3. *Total volume of strength training session in mean ± SD of ibuprofen situation (IS) and placebo situation (PS) in the sets of maximums repetitions in the bench press and squat exercises*

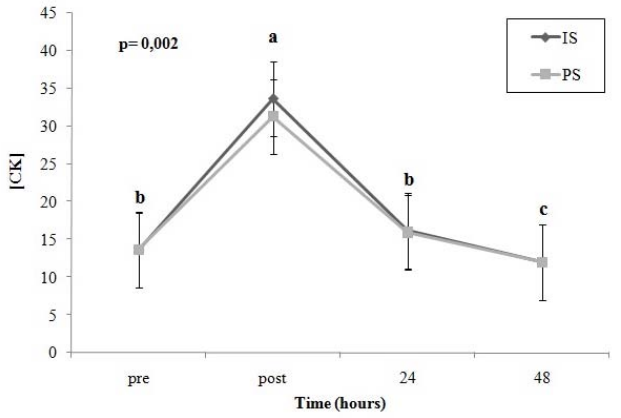


Fig. 4. *Creatine Kinase [CK] level in mean ± SD, strength training session, in which letters represent statistically significant differences between [CK] in both situations ibuprofen situation (IS) and placebo situation (PS)*

gated the effect on increased performance and muscle damage extent of chronic ingestion of Vicoprofen (hydrocodone opioid with ibuprofen), ibuprofen (200 mg) and placebo after eccentric exercise of stretching the knee in isokinetic equipment. The authors reported a higher torque peak in knee stretch and greater output of maximum eccentric strength with the use of Vicoprofen, but not with ibuprofen, which is in agreement with the present study. The difference in the output of maximum eccentric strength with the use of Vicoprofen may be due to the composition of this drug, with a predominance of the opioid, which has a highly analgesic action. This study did not find any effect of the drug on creatine kinase concentration in strength-trained individuals.

The plasma levels of creatine kinase is often considered as a muscle damage marker, since this protein is cytoplasmic molecule that cannot cross the sarcoplasmic membrane barrier [29-31]. Hasson et al. [5] investigated the influence of using acute ibuprofen (400mg) in strength training and found less delayed onset muscle soreness and no difference in creatine kinase concentration release in the ibuprofen group as compared to the placebo group. It is likely that the reduced muscle soreness found in that group was due to the drug's analgesic effect. These results suggested that even reducing muscle soreness, the use of NSAIDs did not have influence in the muscle damage. In addition, Trappe et al. [17] found that ibuprofen enhanced muscle strength and muscle size when given during a strength training program in older adults.

In the present study, the absence of differences between ibuprofen and placebo possibly occurred since the ibuprofen condition did not improve the quantity of performance muscle mechanical during the strength training session. In addition, the exercise session in the present study consisted of predominant concentric muscle strength (i.e. squat and straight bench press with free weights), which have lower effect on the muscle damage compared with exercises with predominant eccentric forces [32]. Notwithstanding, even with the performance of exercise with predominant concentric forces, the present strength training session resulted in increases in creatine kinase session release immediately after exercise, with no difference between the experimental conditions.

The mechanisms of physiological adaptation generally preclude the use of damaged muscle structures and protect them from further damage [9,17,33]. In addition, suppression of muscle pain by using non-steroidal anti-inflammatory drugs, with the resulting decrease in prostaglandins release and inhibition of COX-2, can impair healing of the lesion and delay the hypertrophic adaptation of the muscle after strength training [7]. The effects of COX-2 include stimulus to the proliferation, differentiation and fusion of myoblasts and satellite cells. Thus, its inhibition can impair the process of muscle anabolism [16] and does not acutely enhance the functional capacity both in aerobic [15,28] and in anaerobic [34-36] activity, as well as during strength training, as suggested by the results of the present study.

The literature suggests that the use of ibuprofen at high doses in sports can have several deleterious effects such as decrease in prostaglandins (PGEs) synthesis in the gastrointestinal tract, changes in renal function, peripheral edema, hypertension, and inhibition of renal excretion of water and sodium and hyperkalemia, which results from the reduced release of rennin mediated by PGEs [27]. This is because in inflammatory sites, COX-2 has the function of synthesizing PGEs with pro-inflammatory action, which activate nociceptors and increase the sense of pain. In renal and gastrointestinal sites, however, COX-1 synthesizes PGEs for tissue protection, hence the side effects of these drugs associated with renal and gastrointestinal problems. These inhibitory effects on COX by non-steroidal anti-inflammatory drugs can compromise the organic integrity of the individual, contraindicating its administration as an ergogenic agent in such anaerobic activities like strength training.

In summary, the use of Ibuprofen at a single and maximum daily dose of 1.2 grams did not result in an enhanced performance during a high volume strength training session. Moreover, the use of non-steroidal anti-inflammatory drug Ibuprofen did not affect the levels of creatine kinase in the evaluated individuals. The observed extent of lesion was likely due to the muscle group recruited and the high volume of the strength training with the use of primary exercises bench press and squat with free weights.

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**Declaration of interest**

The author reports no conflicts of interest.

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