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Acute Effects of Foam Rolling on Cycling Performance: A Randomized Cross-Over Study

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ABSTRACT

International Journal of Exercise Science 14(6): 274-283, 2021. Acute foam rolling protocols may increase range of motion without a negative impact on muscle performance. The main purpose of the present study was to investigate the acute effects of foam rolling on cycling performance (mean power and maximal power), affect and perceived exertion. A secondary aim was to assess the effect of foam rolling on post-exercise muscle soreness. In a random order, ten recreationally trained cyclists (age: 26 ± 5 years; height 1.76 ± 0.06 m; total body mass 78.3 ± 19.8 kg; cycling experience: 5.6 ± 5.3 years; 4.1 ± 1.3 cycling sessions per week and 1.4 ± 1.4 strength sessions per week) were submitted to the following experimental conditions (separated by one week) before performing a three-minute, all-out cycling test: foam rolling or control. During foam rolling protocol, participants were instructed to roll back and forth on one leg and to place the opposite leg crossed over, from the proximal to the distal portion of the rectus femoris and vastus lateralis during one set of sixty seconds for each muscle group. Feeling scale (10 min pre and post-test), CR-10 scale of perceived exertion (ten-minute post-test), pressure pain threshold (pre and 24 h post-test) and mean/maximal power were assessed. No significant differences were observed between conditions for mean and maximal power, affect, perceived exertion, and pressure pain threshold (all $p > 0.05$). In conclusion, a pre-exercise acute session of self-myofascial release does not improve performance and post-exercise muscle soreness of recreationally trained cyclists.

KEY WORDS: Cyclists, self-myofascial release, sports performance

INTRODUCTION

Acute foam rolling (FR) protocols may increase range of motion without a negative impact on muscle performance (2, 14). Additionally, significant reductions in delayed onset muscle soreness, rate of perceived exertion and sensation of fatigue are other FR-related outcomes (10, 12, 18). Briefly, a reduced neural inhibition and a peripheral change of the mechanical tissue properties are mechanisms that often explain the aforementioned positive effects of FR (3). Additionally, increases in blood flow, metabolites removal, edema reduction and oxygen delivery to the muscle are described to justify the adoption of such recovery tool (18).

Cycling performance is strongly dependent of internal (e.g. muscle energy metabolism, nutrition) and external factors (e.g. bicycle mass, aerodynamics, body mass) (13). As a result, it is reasonable to expect that adjustments in one or more of those variables might improve performance, especially in non-elite cycling athletes (13, 18). In this context, due to the aforementioned benefits, performing a FR protocol pre-exercise could represent an interesting tool for individuals engaged in cycling activities (18). However, to the best of the authors´ knowledge, possible effects of FR in cycling performance remain under investigated, especially in activities longer than 30 seconds (8). Then, the aim of the present study was to assess the effect of FR protocol on cycling performance. The study initial hypothesis was that FR would enhance cycling performance and reduce subjective feelings of fatigue and muscle soreness.

METHODS

Participants

Ten recreationally-trained men (age: 26 ± 5 years; height: 1.76 ± 0.06 m; total body mass: 78.3 ± 19.8 kg; cycling experience: 5.6 ± 5.3 years; 4.1 ± 1.3 cycling sessions per week and 1.4 ± 1.4 strength sessions per week) volunteered for the study. The sample size was justified by a priori power analysis in Gpower software (Version 3.1.9.2; Universität Kiel, Kiel, Germany) based on a pilot study with the three-minute all out test (control condition vs foam rolling 1-min) with a target effect size difference of 0.70, an alpha level of 0.05, and a power (1 – β) of 0.80. The *a priori* power analysis suggested a minimal sample of ten subjects. To be able to participate the study, participants should present minimal six months of training experience and an average traveled distance of 150 kilometers/week for the last three months prior to the study. Athletes could not be performing self-myofascial release or any manual therapy technique at last three months. Subjects also had to be free of any musculoskeletal injury within the past six months. All procedures were in accordance with the Declaration of Helsinki and were carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (17). All subjects read and signed a consent form approved by the Ethics Committee of the local university (Protocol: 2.527.071).

Protocol

A random crossover, repeated measure design was implemented to investigate the effects of FR on subjects´ soreness and performance measures. Participants of the study were asked to report to the laboratory on two different days, separated by seven days from each other. Anthropometric data (age, height, total body mass, and humerus length) were collected during the first visit. Then, in a random order, participants were submitted to a FR or control (CON) protocol pre-exercise. During each experimental condition, pressure-pain threshold (PPT) of rectus femoris and vastus lateralis muscles, rate of perceived exertion and pleasure/displeasure were collected pre and post an all-out cycling test, in which maximal and mean power were assessed (Figure 1). Participants were instructed to refrain from any exercise modality 48 hours pre exercise, avoid caffeine or any stimulating supplement containing beverages in the days of the experimental sessions and abstain from any food intake 90 minutes prior to the assessments. Both sessions were supervised by the same researchers.

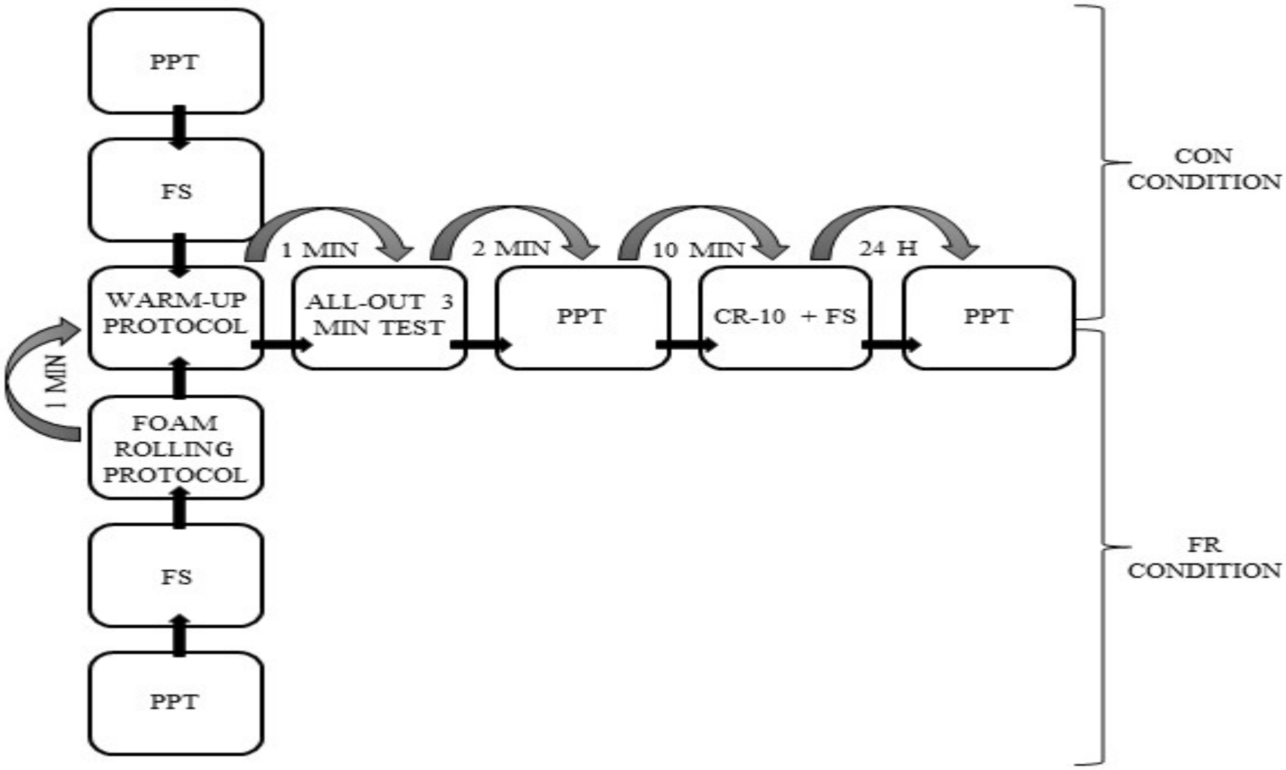

Figure 1. Experimental design of the study. PPT= pressure pain threshold; FS= feeling scale; FR= foam rolling; CON= control.

Subjects performed self-myofascial release on the rectus femoris (RF) and vastus lateralis (VL) muscles unilaterally with a foam roller (Brand: Trigger Points, model: GRID®, Yokohama, Japan). The foam roll (33 cm length x 14 cm diameter) was composed by a hard-hollow core covered by a 15 mm thick layer of ethylene vinyl acetate. The subjects were instructed to perform the myofascial release as previously described by Phillips et al. (19). Subjects were instructed to begin in a plank position and place the foam roller at the most proximal portion of the RF and VL. Then, a dorsal position was adopted for hamstrings, tibialis anterior and gastrocnemius muscles of one leg, while the opposite leg was placed in a crossed over manner position (Figure 2). A numerical scale of perception of discomfort adapted from previous studies investigating stretching was adopted in order to adjust the pressure (16). This scale varies from 0% (no pressure discomfort at all) to 100% (maximal tolerable pressure discomfort). They were instructed to roll back and forth both legs from the proximal to the distal portion of each muscle group in one fluid motion and to exert 70 to 90 of subjects' perception of discomfort. One set of 60 seconds was performed for each muscle group. A one-minute rest was allowed between each leg.

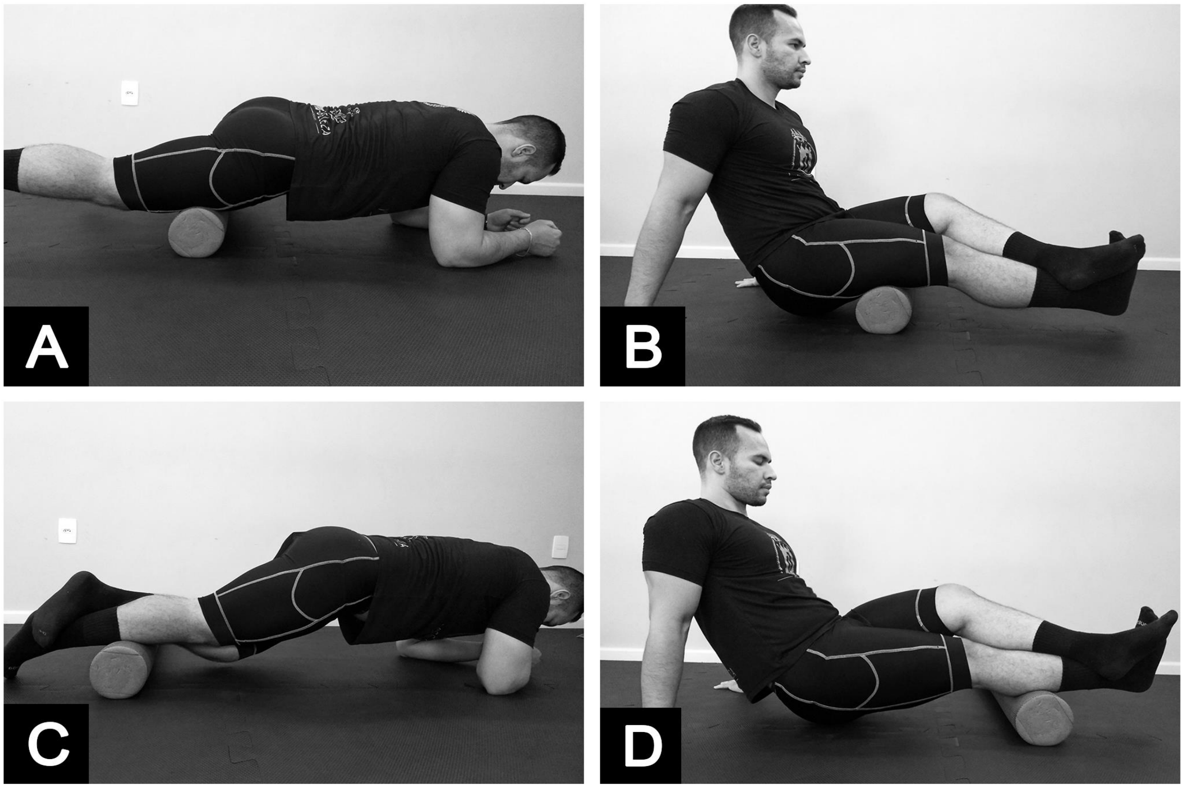

Figure 2. Demonstration of foam rolling protocol adopted during the study in rectus femoris (A), hamstrings (B), tibialis anterior (C), and gastrocnemius (D) muscle groups.

A three-minute, all out test was adopted in order to assess maximal and mean power (23). All tests were performed in a cycling smarter trainer (CompuTrainer®), in the same bicycle adjusted following each individual´s preference. A specific trainer rear tire (Vittoria Zaffiro Pro For Roller 700 x 23 Folding®) was installed to match roller manufacture´s recommendation to improve measures accuracy. The protocol was performed in a simulated flat route with 100% drag air emulation programed at RACERMATE ONE™ software. Initially, a ten-minute self-selected cadence and gear warm-up was fulfilled following the manufacturer instruction to set a proper resistance coefficient between the trainer and bicycle tire. Subjects were then asked to increase their cadence during the last five seconds of the baseline period before initiate the all-out protocol itself. Then, participants were instructed to cycling at as higher power output as possible throughout the three-minute period. Strong verbal encouragement was provided throughout the test, although the subjects were not informed of the elapsed time to prevent pacing. Data (maximal and mean power) were processed by the RACERMATE ONE™ software, being expressed as Watts (W).

A digital algometer (DD20 model, Instrutherm Inc., São Paulo, SP, Brazil) was used to assess participants´ PPT, according to the methodology described by Fischer (5). The pressure algometer was applied to two specifically marked point locations. The RF and VL muscles were used as point of references. Measurements were taken immediately before, two minutes, and 24-hours post each exercise session. The readings of each measure were obtained by applying a gradually increasing force to the tested point through the algometer until a painful sensation was experienced. Participants were instructed to speak ''yes'' at the moment they felt pain rather than pressure. For all participants, three measurements of each muscle were performed by the same researcher, with 30-seconds of interval being adopted between each measurement. The average of the three different series of measurements was calculated and used in the further statistical calculations, being expressed as kilogram-force (kgf) units.

CR-10 scale was used to assess participants´ rate of perceived exertion (RPE) ten minutes after the cycling test in each experimental condition (6). Briefly, a Likert type scale of 11 points was adopted, varying from 0 to 10, initiated with "rest" and terminated with "maximal." Participants were individually instructed on how to properly use the scale in order to assess their intensity of effort experienced during exercise. Values were expressed as Arbitrary Units (AU).

Pleasure/ displeasure was measured using the Feeling Scale (FS) ten minutes pre and post the cycling test (9, 20). Participants rated their current feelings on an 11-point bipolar scale ranging from +5 to -5, with verbal anchors of very good (+5), good (+3), fairly good (+1), neutral (0), fairly bad (-1), bad (-3), and very bad (-5). Values were expressed as Arbitrary Units (AU).

Statistical Analysis
The normality and homogeneity of the variances were verified using the Shapiro-Wilk and Levene tests, respectively. Prior to analysis, all data were log-transformed for analysis to reduce bias arising from non-uniformity error (heteroscedasticity). The mean, standard deviation (SD) and 95% confidence intervals (CI) were used after data normality was assumed. To compare mean values of the descriptive variables, mean and maximal power, CR10 and felling scale between-conditions (CON vs FR), a paired t-test was used. Effect sizes (ES) of the variables using the standardized difference based on Cohen's d units by means (d value) (4). A repeated-measures ANOVA (3x2) was used to compare time effect (pre, post and post 24 hours) and two conditions (CON vs FR) in algometer pressure-pain threshold of rectus femoris and vastus lateralis muscles. Post-hoc comparisons were performed with the Bonferroni correction. Assumptions of sphericity were evaluated using Mauchly's test. Where sphericity was violated ($p < 0.05$), the Greenhouse–Geisser correction factor was applied. In addition, effect sizes were evaluated using a partial eta squared (η^2_p), with < 0.06, 0.06 - 0.14 and, > 0.14 indicating a small, medium, and large effect, respectively. The adopted significance was 5%. All analyses were conducted in SPSS-22.0 software (IBM Corp., Armonk, NY, USA).

RESULTS

3-min all-out cycling test: No significant effect of conditions for 3-min all-out cycling test was observed in mean ($p = 0.884$, ES = 0.07; mean and CI95% difference = -3.3, -26.4 to 19.7 watts) and maximal power ($p = 0.577$, ES = 0.27; mean and CI95% difference = 39.5, -20.3 to 99.4 watts) (Figure 3). No significant effect of conditions for 3-min, all-out cycling test was observed in CR10 scale ($p = 0.852$, ES = 0.09; mean and CI95% difference = -0.11, -0.82 to 0.60 arbitrary units) and feeling scale ($p = 0.539$, ES = 0.30; mean and CI95% difference = 1.00, -1.57 to 3.57 arbitrary units) (Figure 4).

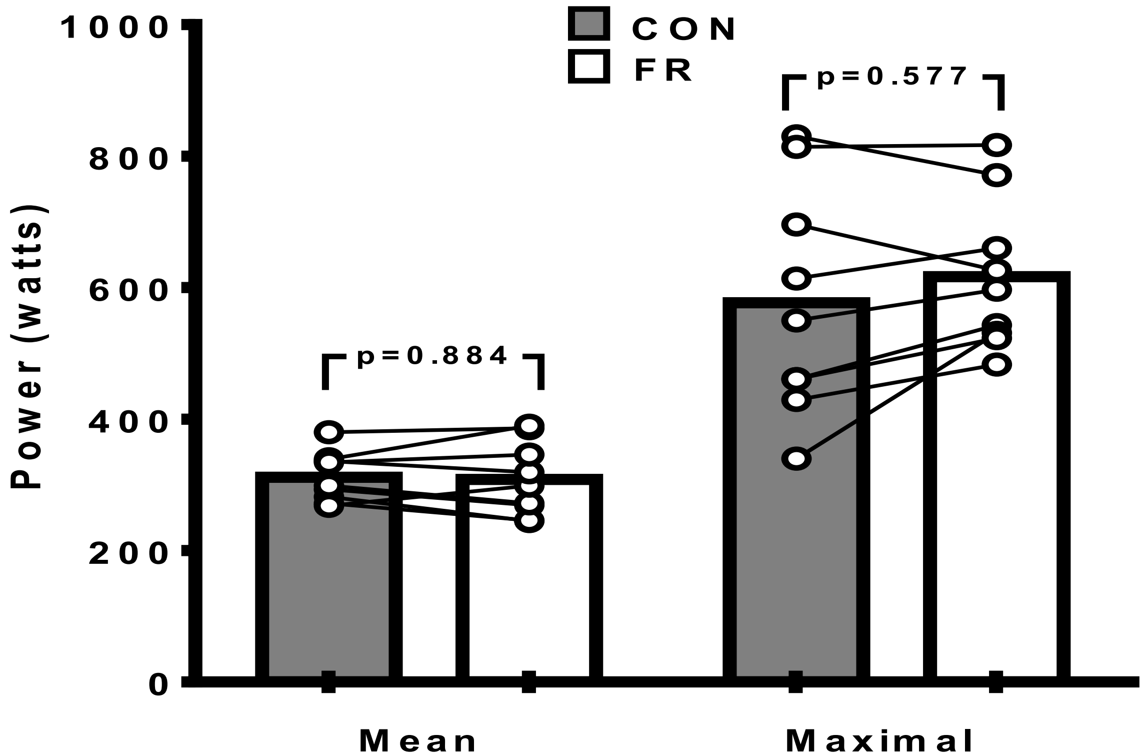

Figure 3. Mean and maximal power for 3-min all-out cycling test in control (CON - grey bar) and foam rolling (FR – white bar) conditions.

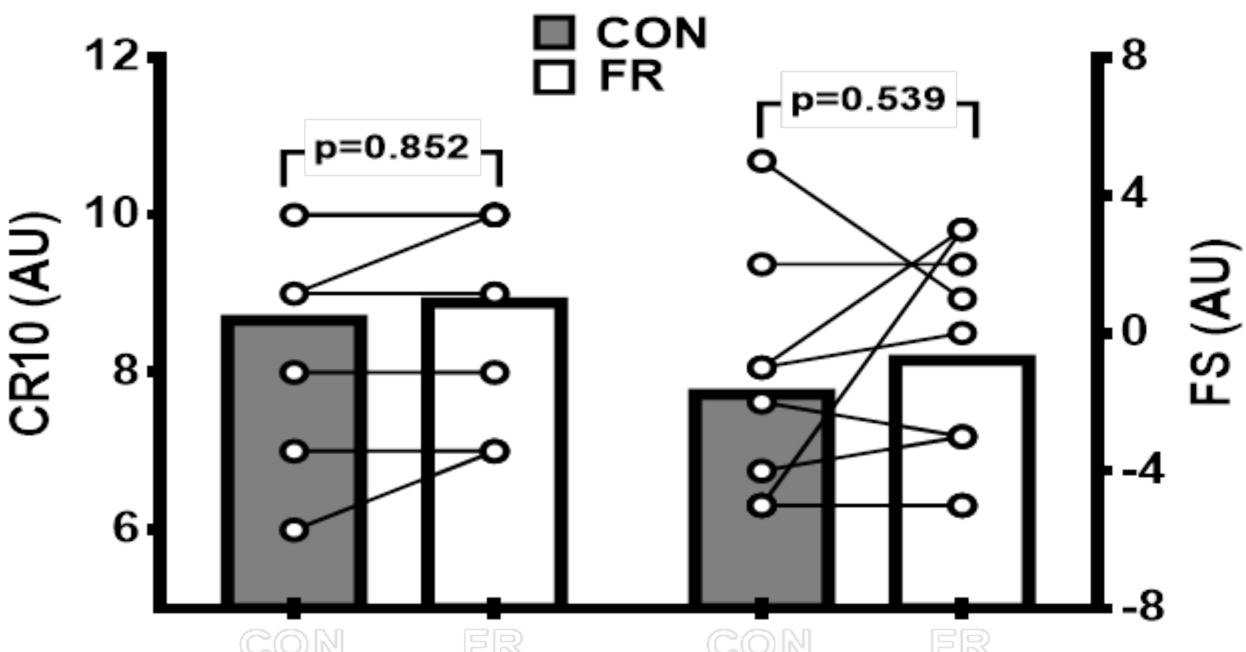

Figure 4. CR-10 and feeling scales (FS) collected 10 min after the 3-min all-out cycling test in control (CON - grey bar) and foam rolling (FR – white bar) conditions.

Pressure Pain Threshold: A significant condition x time interaction was observed ($F_{2,16}$ = 5.254, p = 0.026, η^2_p = 0.276) for pressure pain threshold (PPT) in rectus femoris muscle. There was a significant difference between pre-test and post 24 hours for rectus femoris muscle only in FR (p = 0.036, mean and CI95% difference = -0.57, -0.12 to -1.92 kg). No significant condition x time interaction ($F_{2,16}$ = 1.907, p = 0.181, η^2_p = 0.192) for vastus lateralis muscle was observed (Table 1).

Table 1. Algometer pressure-pain threshold of rectus femoris and vastus lateralis muscles in pre, post-test, and post 24 hours for control (CON) and foam rolling (FR) conditions (mean ±SD).

Variables	Pre Test	Post Test	Post 24h	time*group	
				P-value	η^2_p
Rectus Femoris (kgf)					
CON	4.80 ± 0.89	4.30 ± 1.35	4.23 ± 1.34	0.026	0.376
FR	5.37 ± 1.30	4.78 ± 1.96	4.38 ± 1.28[A]		
Vastus Lateralis (kgf)					
CON	4.31 ± 0.89	4.39 ± 1.23	4.14 ± 1.20	0.181	0.192
FR	4.98 ± 1.43	4.35 ± 1.89	4.54 ± 1.61		

A = Significantly greater than the pre-test value (p < 0.05).

DISCUSSION

The aim of the present study was to assess the effect of FR on cycling performance, assessed in a three-minute, all-out cycling test in recreationally trained men. The main finding was that FR did not enhance cycling performance. Additionally, the FR protocol did affect post-exercise muscle soreness. It is important to stress that, to the author´s knowledge, this is the first study to assess the adoption of a FR protocol previously to a three-minute, all-out cycling test.

Regarding muscle performance, the initial hypothesis was not confirmed, since no significant difference was observed between experimental conditions in maximal and mean power. A similar result was reported by Shalfawi et al., where no significant effect was induced by a self-myofascial protocol in Wingate- peak/mean power and time to exhaustion on an incremental cycling test (21). However, the results from Shalfawi et al. must be not extrapolated to cycling practitioners, since assessments were performed in speed skaters (21). Differently from the current investigation, a significant increase in power output was described by Phillips et al. when adopting a 60-seconds FR protocol. However, such dependent variable was assessed through a vertical jump test, which must be considered in an attempt to compare the results of both studies (19).

Mixed results regarding muscle performance and the use of self-myofascial devices have been previously reported (7, 10, 14, 15). Together, these investigations seem to suggest that the positive effects of FR on performance are protocol duration-dependent, with larger effects being observed in protocols adopting 90 seconds of foam roller or roller massager use per muscle group (3 sets of 30 s) and no effects with protocols shorter than 30 seconds (7,10,22). Then, the duration adopted in the present study (60 seconds per muscle group), although previously supported by Phillips et al. (19), might not have been sufficient to induce a significant effect of FR on performance measures (maximal and mean power). It is important to note that the absence of studies assessing the effects of FR on a three-minute cycling test and the short duration of the tests usually adopted to assess performance in other studies limit possible comparisons with the present investigation. Therefore, an eventual positive effect with the adoption of longer FR duration protocols and exercise tests should not be completely discarded. It is also important to note that, from a practical/clinical standpoint, the average improvement of 0.7% induced by FR protocols, as previously described by meta-analytic data, may not be of great relevance for recreationally-trained subjects, as the participants of this study. In addition, in regard of muscle power, the improvement in jump and strength performance induced by FR seems to be negligible (24).

Feeling and CR-10 scales were used to assess participants' subjective pleasure/displeasure and perceived effort, respectively. No significant difference between experimental conditions was observed for both variables. Such analysis is still rare on literature, especially regarding FS, limiting possible comparisons between the present study and other investigations. A significant lower level of fatigue was described by Healey et al. when a FR protocol was performed before a series of athletic tests (vertical jump height and power, isometric force, and agility) compared to a control condition (10). However, the CR-10 score did not differ between conditions. It is important to note that, differently from the present study, Healey et al. adopted a plank exercise protocol during the control condition (10). Additionally, differences in the sample characteristics (gender), the foam rollers used, and the tests adopted during the intervention might help to explain the distinct results between both studies. Futures studies are warranted to further clarify the effects of FR on pleasure feelings and perceived effort of trained cyclists.

Even though a significant decrease in PPT (pre to post 24h) was observed only for the FR protocol, no significant difference was observed between conditions in any time points, refuting the initial hypothesis. Some investigations have pointed FR as a useful tool to reduce exercise induced-muscle soreness/pain (1, 12, 18). However, a recent review by Huges and Ramer described that FR for 90 seconds per muscle group may be the minimal duration necessary to induce a short-term reduction in pain/soreness, with no upper limit, which may help to explain the absence of effects of FR on PPT in the present study (11). Additionally, the variation in the protocols adopted (especially regarding treatment time, cadence, pressure and training status of the participants), besides the instruments used to assess muscle pain/soreness (algometer vs subjective scales), must be considered when trying to explain distinct results between the present study and other investigations (1, 12, 18).

The major limitation of the present study was the short duration of the FR protocol adopted for each muscle group, which might have influenced performance outcomes. Although the duration used in our study was based on a previous self-myofascial release intervention, future investigations adopting FR protocols with longer duration must be encouraged (19). It is also important to note that these results must not be extrapolated to subjects with different training status, especially athletes, in which even a small performance improvement may represent relevant training/competitive results. Additionally, the acute responses reported may not be extrapolated to a chronic context. Then, future interventions aiming to assess long-term effects of FR in cycling-related parameters must be performed to help clarify these findings.

In conclusion, the present study shows that no benefits in performance or recovery parameters are experienced by recreationally trained cyclists from a self-myofascial release acute intervention composed of one set of 60-seconds per muscle group application. However, these findings suggest that further investigations are required in order to assess the effects of long duration-FR protocols in cycling performance.

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