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Does Foam Rolling Really Work?

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Research Article

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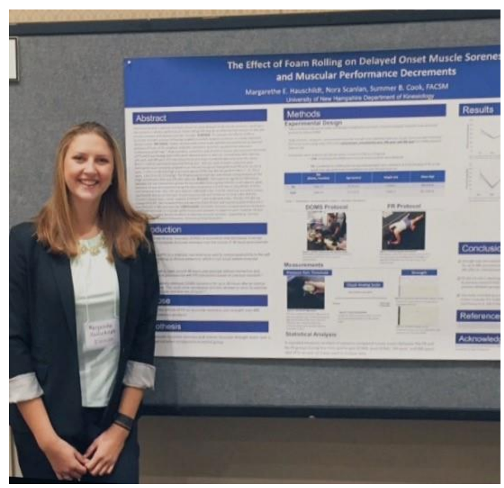
Delayed onset muscle soreness (DOMS) is an enigma to the exercise world: researchers are still trying to understand the process by which DOMS occurs and figure out exactly which modalities, or treatment methods, can alleviate DOMS. You may have experienced DOMS after working out at a higher intensity than usual, after going on a long hike that you're unaccustomed to, or back in high school when you started preseason workouts. Foam rolling is just one proposed modality for reducing the length of time an individual experiences a high level of perceived soreness after exercise. This modality is becoming increasingly popular in gyms, schools, and physical therapy clinics across the nation, so research on its effectiveness is extremely relevant to anyone who suffers from DOMS.



Margarethe Hauschildt

As an exercise science major, the increasing popularity of foam rollers originally caught my attention, and the limited research on how they actually work held my attention and led me to help develop a collaborative study. I wanted to test whether foam rolling could reduce soreness if it was completed after an intense bout of exercise and every 24 hours post-exercise for four consecutive days. With the help of my mentor, Dr. Summer Cook, I received a Summer Undergraduate Research Fellowship (SURF) in 2016 to conduct this inquiry. My partner in this study, fellow Honors Exercise Science major Nora Scanlan, also received a SURF grant for her part of our collaborative project. Nora focused on the effect foam rolling has on inflammatory proteins found in blood due to DOMS. We used the same participants and the same protocol, but I measured strength and soreness and Nora took samples of the participants' blood to analyze after each time point in our study. The purpose of my part of the study was to discover whether foam rolling could attenuate, or lessen, DOMS over seventy-two hours post-exercise and to determine whether muscle strength, which declines with DOMS, could be regained faster with foam rolling.

Why Might Foam Rolling Work?

If an individual completes an intense bout of exercise that he or she is unaccustomed to, the muscle groups used will have more inflammation than would occur following that individual's typical exercise routine (1). Micro tears in muscles resulting from unaccustomed exercise can cause stiffness and pain upon palpation or movement, causing the muscle to have a lower force production (2). If the muscle has lower force production, then activities of daily living, such as walking up and down stairs, and athletic performance, such as the force a soccer player can produce for a penalty kick, both may be compromised. Some muscle damage is inevitable following high volumes of exercise, but methods exist that can lessen exercise-induced muscle damage.

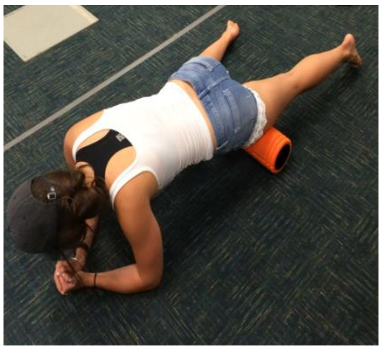


Figure 1. Participant foam rolling her quadriceps

Foam rolling offers a potential way to alleviate DOMS symptoms and restore contractility, or an individual's ability to produce force as needed in sports and working out, faster than if an individual does not foam roll. To foam roll the quadriceps, an individual lies on the roller face down with elbows on the ground and the roller perpendicular to the torso and just below the hip (see Figure 1). Then, the individual smoothly rolls his or her body at a set cadence over the roller until it reaches the top of the knee. Previous research suggests that foam rolling loosens the muscle fibers by creating a frictional force to warm up the muscle so that optimal force can still be reached (2,3). Based on these research studies, I hypothesized that foam rolling could reduce soreness and allow an individual to regain strength faster than if he or she does not foam roll.

Methods

Twenty-one recreationally or moderately active males and females aged 18-24 years old volunteered for this study. Participants were included in the study if they were classified as recreationally active. Participants could not be pregnant or ill, and did not have any previous knee or ankle injuries. Participants visited the lab five times: (1) for a familiarization session, (2) for the DOMS protocol (described below) and for assessment at 1 hour post-exercise, (3) for assessment at 24 hours post-exercise, (4) 48 hours post-exercise, and (5) 72 hours post-exercise.

I compared strength and soreness measurements for these time points through 72 hours post-exercise to see whether foam rolling had a significant effect on attenuating DOMS and restoring strength. I knew that after an intense bout of exercise, peak strength decreases due to extreme fatigue for a period of time, and soreness increases. From my measurements, I tried to find out if foam rolling would help participants regain peak strength faster and lessen soreness at an earlier time point than participants who did not foam roll. I used a repeated measures ANOVA (statistics equation used to see if a dependent variable is significantly different over time) to assess the changes within groups over the time points (pre-exercise, immediately post-exercise, one hour post, 24 hours post, 48 hours post, and 72 hours post) to determine whether the data was significant.

Familiarization Session

Figure 2. Author (right) with her research partner, Nora Scanlan (left).

At the familiarization session, participants came into the Biomechanics and Motor Control Laboratory in New Hampshire Hall at UNH to complete an informed consent document that the UNH Institutional Review Board had approved. Nora and I surveyed participants to assess their current exercise level and general health using the Rapid Assessment of Physical Activity survey, and we measured their heights and weights (see Figure 2). I assessed the participants' pain-pressure threshold by pressing a small handheld device called an algometer onto each of his or her legs. The participants were instructed to say "pain" when the sensation of pressure tuned into the sensation of pain at the site of the device. When the participant said "pain," I stopped pressing the device into his or her leg and recorded the force that had been applied to the muscle. Following this, each participant filled out a visual analog scale to depict perceived soreness. This scale was a line 10 cm long on which the participant marked where his or her perceived soreness lay, from 0 soreness at the left end of the line to a maximum soreness of 10 at the right end of the line.

We then had participants complete a practice session during which we taught them how to contract their quadriceps when doing a knee extension exercise on a Humac Norm isokinetic dynamometer (see Figure 3). The dynamometer is a machine that the participant sat in, with a pad attached to his or her ankle. The machine then produced a torque output measurement based on how forcefully the participant pushed against the pad in an isometric movement, where the pad does not move, and in an isokinetic movement, where the pad can move through a range of motion at a set velocity. The isokinetic contractions were performed in a concentric-eccentric manner, where the muscles shorten during the concentric phase and lengthen during the eccentric phase. As a result, I was able to measure the strength of a participant's quadriceps in three different ways—isometric, concentric, and eccentric—to get a full grasp on overall strength during each time point.

Figure 3. Author testing the DOMS protocol in the dynamometer.

We placed the participants randomly into one of two groups: foam rolling or control. We instructed participants in the foam rolling group on how to use the foam roller on the inner, outer, and middle thigh on the leg chosen at a cadence of 30 beats·min^{-1} for six minutes (two sets of one minute on each part of the thigh). I measured pain-pressure threshold and soreness on both legs. Then I helped the participant get adjusted in the dynamometer so that I could measure peak isometric and isokinetic torque of their right quadriceps. We set range of motion from 90° flexion to full (160°–180°) extension for each participant on each leg. Participants started the familiarization exercise session by completing a series of three isometric contractions of the quadriceps, pushing upwards against the non-moving pad attached to the ankle. The dynamometer was connected to the BioPac Data Collection System that allowed measured torque output to be displayed and analyzed. To measure peak isometric torque, the participant's knee was set to 60° of his or her full range of motion, and then he or she extended the leg as hard as possible against the immovable pad moving for three to five seconds. The highest torque of the three trials was recorded.

Participants then completed two trials of six isokinetic contractions of the quadriceps muscles (three concentric and three eccentric per trial) at a set speed of 60 Nms^{-1} on each leg. The participant was instructed to extend the leg against the pad as hard as possible, causing the muscle to contract concentrically, and then continue to extend the leg against the force of the pad, which then moved the leg down towards 90° flexion in an eccentric movement. I recorded the highest force produced from both the concentric and eccentric contractions in each of the trials, and then averaged the trials to create one value for concentric strength and one for eccentric strength. Each participant then practiced ten repetitions of the concentric-eccentric coupled contractions to prepare for the DOMS protocol. Measurements taken on the familiarization day were not used in the data analysis; rather participants used the practice session to learn the tests they would perform during data collection. Nora and I informed all participants not to exercise, stretch, or take any anti-inflammatory drugs prior to the first testing day or at any time throughout the 72-hour research period, as these all would interfere with and lessen the symptoms of DOMS (which we were trying to induce).

DOMS Protocol

On the day of each participant's DOMS protocol, he or she filled out a pre-exercise compliance form and the soreness scale, and then I took pain-pressure threshold measurements. Nora took a sample of blood from the participant's arm, and then the participant was positioned in the dynamometer. We took pre-exercise measurements of isometric, concentric, and eccentric torques on the leg that was going to be exercised. The participant then followed the DOMS protocol. The goal of our protocol was to make the participants' muscle fibers fatigue enough so that they would be sore and experience substantial DOMS. The protocol consisted of four sets of fifty coupled concentric-eccentric isokinetic contractions at $60°sec^{-1}$, with thirty seconds of rest between each set.

Immediately following the protocol, we took post-exercise measurements of isometric and isokinetic torque. We administered the post-exercise soreness scale and measured the pain-pressure threshold. If in the foam rolling group, the participant engaged in six minutes of foam rolling immediately after all post-exercise measurements were taken. All participants rested for one hour, after which we took all measurements again. The foam rolling group then engaged in foam rolling for another six minutes before going home.

Follow-Up Visits at 24, 48, and 72 Hours

At 24, 48, and 72 hours post-exercise, we took the same measurements of isometric and isokinetic torques, pain-pressure threshold, soreness, and blood. The participants started each follow-up session by filling out a compliance form and subjective pain on the soreness scale, followed by the pain-pressure threshold protocol. Nora took each participant's blood samples. We assessed peak muscle strength on the dynamometer as previously described. If the participant was in the foam rolling group, he or she stayed and completed a 6-minute session of rolling; if not, the participant could leave. Participants were instructed not to exercise, stretch, or take any anti-inflammatory drugs throughout the study.

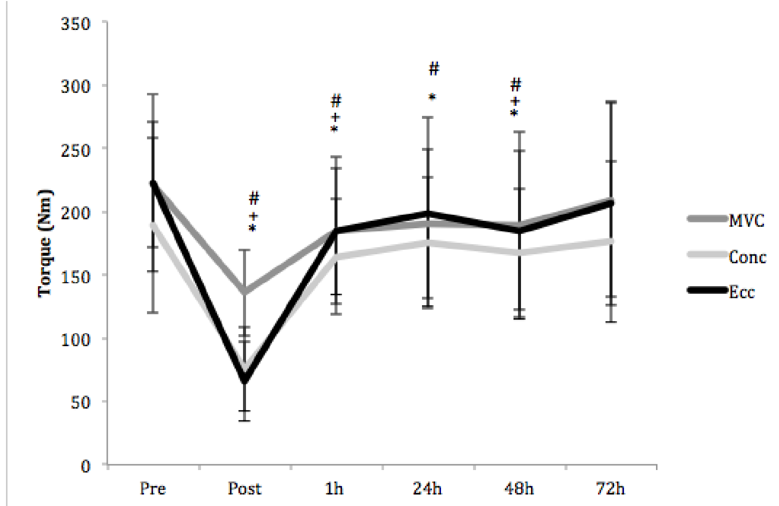


Figure 4. Changes in isometric, concentric, and eccentric torques before and up to 72h after exercise.* represents significant change over time in isometric torque (p<0.05) from pre-exercise measurements; + represents significant change in concentric torque (p<0.05) from pre-exercise measurements; # represents significant change in eccentric torque (p<0.05) from pre-exercise measurements.

Results

We did find that the DOMS protocol successfully induced significant soreness and strength decrements up to 72 hours post-exercise in all participants. However, we found that foam rolling did not have a significant effect on either the attenuation of DOMS symptoms or on restoring strength faster than without foam rolling. The foam-rolling group did not recover strength any faster or have significantly less soreness when compared to the control group.

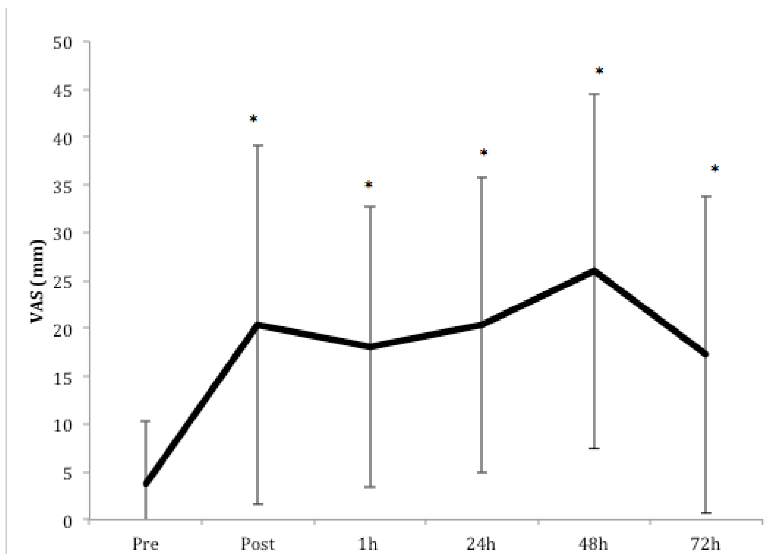


Figure 5. Changes in perceived soreness from the Visual Analog Scale before and up to 72h after exercise.*significant change over time (p<0.05).

One of the goals of this study was to induce soreness and decrease strength to measure the patterns of recovery and to see if foam rolling changed anything—this goal was met, as the participants demonstrated decreased muscle strength and remained extremely sore for days after the exercise. No matter the group (foam rolling or control), participants experienced significant decreases in muscular torque up to 48 hours post-exercise for both isometric and isokinetic contractions (see Figure 4). Participants also experienced soreness up to 24 hours post-exercise and 72 hours post-exercise (based on the soreness scale) (see Figure 5). While there were not any significant differences between the foam rolling or control groups at any time point, we met our goal to make all participants experience symptoms of DOMS.

Future Plans

The attenuation of DOMS is always a goal in athletics, at the gym, and for rehabilitation—no one wants to be sore for longer than they have to be. I had hoped that this study would further our knowledge about the effectiveness of foam rolling after exercise, and although the results were not statistically significant, I think that further research could elicit significant results from a larger sample size of participants. Another limitation could have been that all participants were relatively fit coming into the study, so they might not have shown as large a change in soreness as a more unfit population. Since foam rolling is completed when an individual rolls his or her full body weight over the afflicted muscle, this was a variable throughout the study due to different body masses in participants.

I learned a lot throughout this research process, and it is only just the beginning of my career in research and in the field of health sciences. I never realized how much I would learn about the community, exercise science, the scientific process as a whole, or about myself during this process. There were, of course, many problems along the way that I had to overcome. The biggest thing I learned was how to troubleshoot. When the dynamometer did not work properly, when the computer would not load the program I used to record the data, or when a participant forgot to show up during the assigned meeting time, I had to figure it out and develop a solution. I learned that there are innumerable obstacles that will block one's path when setting out to complete a large and complex project.

This project was just the gateway into research for me, and I plan to complete many more studies throughout my career in the exercise science or physical therapy fields. I will be attending Columbia University for my doctorate of physical therapy starting in the fall of 2017, and I plan on continuing research during my graduate education. In addition to publishing my research in *Inquiry*, I presented an oral poster presentation at the New England chapter of the American College of Sports Medicine (NEACSM) conference in October 2016, and an oral presentation at the 2017 Undergraduate Research Conference (URC) at UNH. None of this would have been possible without the help and funding of the Summer Undergraduate Research Fellowship.

I would first like to thank the Hamel Center and Mr. Dana Hamel for allowing me this opportunity to expand my academic borders and learn in a research environment. Without the generous donations to grant me a Summer Undergraduate Research Fellowship, I would not have gained such an experience. I would also like to thank my research partner, Nora Scanlan, for being by my side every step of this journey. Finally, thank you to my research mentor, Dr. Summer Cook, for continually and patiently offering guidance and for always pushing me to become my best. This project would not have been made possible without endless support from these people, and for that I will always be grateful.

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Author and Mentor Bios

Margarethe Hauschildt, from Dover, New Hampshire is an exercise science major and member of the University Honors Program and Honors in Major Program. She will graduate in September 2017 after completing an internship over the summer. Margarethe began researching under her mentor, Dr. Cook, in the summer of 2015, and decided she wanted to delve into a project of her own. She received a Summer Undergraduate Research Fellowship (SURF) in 2016 and through that project learned more about the "behind-the-scenes" work of research: creating a hypothesis, applying for a grant, gathering participants, and analyzing results. She feels her research on the effectiveness of foam rolling is very relevant for anyone experiencing muscle soreness. Margarethe says that writing about her research for *Inquiry's* general audience was challenging but rewarding and, along with her research and Honors Program experience, benefitted her plans for life after UNH. In the fall of 2017 Margarethe will head to Columbia University in New York City, where she will work toward a doctorate in physical therapy.

Summer Cook is an associate professor in the Department of Kinesiology, Exercise Science option. She has been at the University of New Hampshire for seven years in both a teaching and research role. Her main areas of interest are aging, resistance training, and neuromuscular function, and she teaches courses related to those topics. She is also involved with research at UNH more broadly through her service on the Institutional Review Board, the Responsible Conduct of Research Committee, and the Undergraduate Research Conference Committee. Dr. Cook enjoyed working with Margarethe and her research partner on their study of the effectiveness of foam rolling. She says that their research project involved a lot of "pilot testing and practicing to get the delayed onset muscle soreness protocol just right." Together, they learned many new laboratory techniques. Dr. Cook has mentored several undergraduate researchers, and Margarethe is her first *Inquiry* author. She points out that writing for *Inquiry* is quite different from traditional scientific writing, but that it is a nice departure and "gives student researchers a chance to explain more about the process, challenges, and successes experienced through research."