5-2020

The Effects of Self-Myofascial Release and Static Stretching on Acute Hamstrings Range of Motion

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THE EFFECTS OF SELF-MYOFASCIAL RELEASE AND STATIC STRETCHING ON ACUTE HAMSTRINGS RANGE OF MOTION

by

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B.S., Southern Illinois University Carbondale, 2018

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science in Education

School of Human Sciences
in the Graduate School
Southern Illinois University Carbondale
May 2020

RESEARCH PAPER APPROVAL

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A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Master of Science in Education

in the field of Kinesiology

Approved by:

Dr. M. Daniel Becque

Graduate School
Southern Illinois University Carbondale
April 14, 2020

AN ABSTRACT OF THE RESEARCH PAPER OF

Patrick M. McCowen, for the Master of Science in Education degree in Exercise Science, presented on April 9, 2020, at Southern Illinois University Carbondale.

TITLE: THE EFFECTS OF SELF-MYOFASCIAL RELEASE AND STATIC STRETCHING ON ACUTE HAMSTRINGS RANGE OF MOTION

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Despite the chronic effects of self-myofascial release (SMR) techniques such as foam rolling (FR) on flexibility, few studies have examined its acute effects when performed for durations equaling static stretching (SS) warm-up recommendations shown to enhance range of motion (ROM) absent muscle performance deficits. **Purpose:** This study aimed to compare the acute effects of short-duration (30 s per muscle group) SMR via FR and SS on hamstrings ROM. **Methodology:** University students were quasi-randomly allocated to a FR (n = 12; age, 21.58 ± 3.06 yr; height, 172.22 ± 12.03 cm; weight, 164.22 ± 41.80 lb), SS (n = 13; age, 22.08 ± 2.25 yr; height, 171.06 ± 8.31 cm; weight, 168.75 ± 27.21 lb), or control (CON) group (n = 11; age, 21.82 ± 2.32 yr; height, 168.84 ± 8.97 cm; weight, 158.75 ± 34.42 lb) to perform a short bout of FR or SS targeting all major thigh muscle groups or to sit comfortably in the CON immediately following and prior to a hamstrings ROM assessment (Modified Sit-and-Reach test). **Results:** Each condition led to ROM improvements (main effect of time, $p < 0.001$), but these improvements were independent of group allocation. Compared to CON, improvements were greater only after FR, but when comparing interventions, improvements were similar. **Conclusion:** One bout of short-duration FR and SS were equally effective at eliciting acute hamstrings ROM enhancements. FR therefore exists as a viable alternative to SS for acute ROM improvements when performed in the very short-duration.

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INTRODUCTION

The American College of Sports Medicine defines flexibility as the ability to move a joint about its complete range of motion (ROM). This health related component of physical fitness is contingent on numerous factors including muscle, tendon, and ligament compliance and is critical to athletic performance and functional ability due to its potential to prevent injury while facilitating movement (Riebe et al., 2017). Static stretching (SS) has long been recognized as a primary exercise technique used to enhance flexibility, though concerns exist regarding its potentially negative impact on subsequent muscle performance. Recently, self-myofascial release (SMR) has gained attention as an alternative to SS due to its documented effects on ROM.

Developed by Barnes (1997), SMR is a therapy technique designed to elicit histological changes in the myofascial tissue of treated areas. Fascia—a fibrous connective tissue—spans the body and surrounds virtually all internal structures. Consequent to trauma, fascial tissue tightens and can potentiate poor biomechanics and structural misalignment as well as reduce endurance, strength, and motor performance (Barnes, 1997). The intention of SMR is to produce a stretch within the impacted fascia that causes a release and restores myofascial length and thus, frees joint mobility. Various SMR techniques exist, all of which are intended to facilitate this release and promote tissue health.

As such, foam rolling (FR) involves placing body segments on an elongated cylinder (typically covered with or constructed completely of foam) and rolling up and down a selected area with one's body weight as the applied force. Some studies have demonstrated flexibility improvements from this technique exceeding those observed after SS (e.g., Su et al., 2017), though the complete body of research is limited. Of the studies that have been conducted, there is little consistency between protocols in terms of exercise programming variables such as FR duration and technique, making practical recommendations difficult. Further complicating the matter is that most of the research details only chronic effects of FR while the acute effects remain largely undetermined. However, one recent study examining the acute effects found significant knee joint ROM improvements resulting from a FR treatment (MacDonald et al., 2013), suggesting that this research area warrants further exploration.

Understanding factors that can influence ROM in the short-term is critical as flexibility can be transiently modulated to produce desirable improvements in ROM immediately before the performance of a skill. These transient gains are important as limited ROM restricts movement, and movement exceeding a joint's ROM may cause tissue damage (Riebe et al., 2017). This is largely why flexibility exercises should be included in warm-up routines as various athletic, occupational, and functional activities require movements greater than a joint's typical ROM. In this context, SS and FR assume a heightened importance considering their acute effects on ROM.

In light of historical concerns that performing flexibility exercise prior to skill execution results in muscle performance deficits, a recent review concluded that SS causes inconsequential negative effects when performed in the short-duration (≤ 60 s per muscle group; Chaabene et al., 2019) while FR studies have demonstrated ROM improvements without muscle impairments (MacDonald et al., 2013). Unfortunately, few studies demonstrate these improvements with short-duration FR, suggesting that while it can transiently enhance ROM without hampering performance, exercise duration must exceed that which is recommended for SS to garner similar benefits. Additionally, FR studies examining the effects of shorter durations rarely approach very short durations (around 30 s per muscle group) which are commonly practiced for SS exercises prior to skill performance. If FR were to be seen as a viable alternative to SS as part of a warm-up routine, it would need to show similar positive effects on ROM at durations equaling those practiced for SS, which tend to be short. Considering this, the need exists for a study comparing the acute effects of short-duration SS and FR on ROM. The purpose of this study therefore was to compare the acute effects of short-duration (30 s per muscle group) SMR via FR and SS on hamstrings ROM. Considering the extant literature, it was hypothesized that FR and SS would lead to significant improvements in hamstrings ROM over a non-active control (CON) and that these improvements would be greater following a bout of FR.

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METHODOLOGY

Using a quasi-randomized group pretest posttest design, participants were allocated to a FR, SS, or CON group after completing a baseline hamstrings ROM screening session. Participants subsequently reported to perform their assigned condition following and prior to hamstrings ROM pre- and posttests, respectively. All testing was conducted in the Department of Kinesiology's Exercise Physiology Laboratory at Southern Illinois University Carbondale (SIUC) during the Spring 2020 semester. All recruitment, intervention, and data collection procedures were approved by the SIUC Human Subjects Committee and written informed consent was obtained from participants prior to this study's commencement.

Participants

College-aged university students were recruited from courses offered by the SIUC Department of Kinesiology to take part in this study. Students were read a classroom script detailing basic information regarding the purpose of this study and their potential involvement. Eligible participants were those that were 18 years or older and free of any injury precluding their participation in the treatments or hamstrings ROM assessment method detailed in the classroom script and study information handout provided. If interested, eligible students were asked to contact the lead investigator via email to schedule their hamstrings ROM screening session to be formally enrolled in this study.

Experimental Procedures

Enrolled participants reported to the Exercise Physiology Laboratory to perform their hamstrings ROM screening assessment at baseline. Upon arrival, all participants were given a voluntary informed consent form to read and sign following an explanation of the study and a time period to ask questions if necessary. Participants then had their weight and height measured using a digital scale (LifeSource; A&D Medical, Milpitas, CA) and standard stadiometer, respectively. Participants were then given instructions on how to perform the Modified Sit-and-Reach (MSR) test—a measure of hamstring extensibility accounting for proportional differences between arms and legs (Hopkins & Hoeger, 1992)—with the evaluation instrument (BASELINE Modified Sit And Reach; Fabrication Enterprises Inc., White Plains, NY). All MSR procedures performed were consistent with those detailed by McArdle et al. (2014) with the exception of one: flexibility scores were recorded to the nearest 0.125 in to increase measurement sensitivity in this study as opposed to the nearest 0.25 in. Three trials were performed and mean baseline hamstrings ROM was computed for each participant.

Participants were then assigned a hamstrings extensibility rating (e.g., good, average, poor, etc.) based on MSR normative data reported by McArdle et al. (2014) according to their mean baseline ROM score. Participants were excluded from the study if their mean baseline ROM score corresponded to an extensibility rating of excellent (> 20 in for males aged 18-35, > 24 in for females aged 18-25, and > 25 in for females aged 26-35) to account for possible ceiling effects of hamstrings flexibility. No participants were excluded from this study for having such ratings.

Male and female participants were then ranked in order of most to least flexible based on mean baseline ROM scores. Starting with the most flexible, each ranked list was divided into blocks of three. Male and female participants were then manually randomized into a FR, SS, or CON group out of their block independently. In the case of a block of one or two participants (when *n* was not divisible by three), a coin was flipped to allocate the participants into the FR or SS group. Group assignment was conducted in this way in an effort to counterbalance males and females and ensure similar mean baseline hamstrings extensibility among groups.

Following allocation, participants reported to the laboratory at a time scheduled during the screening session to perform their predetermined protocol. Upon arrival, participants were notified as to what group they were assigned to and what their subsequent involvement would entail. They were again provided instructions on how to perform the MSR procedure before performing their hamstrings ROM pretest. Participants then performed one of two treatments or sat comfortably if assigned to the CON group following the MSR pretest. Immediately post-intervention or CON condition, participants performed their hamstrings ROM posttest. All screening and follow-up sessions were conducted during a three week period and all follow-up sessions (i.e., data collection sessions) occurred no later than two weeks after screening.

Study Conditions

The FR and SS interventions used in this study were consistent with those potentially used as a pre-competitive or exercise warm-up to garner acute enhancements in muscle extensibility as they transiently targeted the major muscles of the bilateral femoral regions.

Foam Roll

Participants assigned to the FR group performed four FR exercises targeting all regions of both thighs. Participants were instructed to lie on the foam roller with the roller situated proximal to the hip joint on the region of the thigh being rolled. Placing as much body weight on the foam roller as they could reasonably tolerate, participants were instructed to roll down their thigh using small, undulating movements until they reached a point immediately superior to their knee joint. At this point, participants were instructed to return the foam roller to its starting position in one continuous motion. Each exercise was performed for 30 s at a rate of approximately 2-3 cycles per exercise. Starting with the right leg, FR exercises were performed in the following order before being performed on the opposite thigh: medial, lateral, anterior, posterior. All exercises were performed with an 18 x 6 in high density foam roller (PRO-FORM; ICON Health & Fitness Inc., Logan, UT) and detailed instructions and demonstrations were given prior to exercise performance. Considering the need for method replication highlighted by Cheatham et al. (2015), the FR technique employed was adapted from MacDonald et al. (2013) who found a bout of SMR performed in this way effective for acutely enhancing knee joint ROM absent any muscle performance deficits. However, this study used shorter FR exercise durations (one repetition of 30 s vs. two repetitions of 1 min) to allow for comparisons against commonly practiced SS durations.

Static Stretch

Participants assigned to the SS group performed four SS exercises (standing side lunge, seated iliotibial band stretch, laying quadriceps stretch, and seated hamstring stretch) targeting identical regions of both thighs. Participants were instructed to stretch each muscle group to the point of light to moderate discomfort and maintain that level of discomfort throughout each exercise lasting 30 s. Starting with the right leg, SS exercises targeted the thigh regions in the same order as the FR exercises before being performed on the opposite thigh. Detailed instructions and demonstrations were given prior to exercise performance. The SS duration used in this study—which dictated the FR exercise duration—was selected in light of a recent review concluding that short-duration SS (≤ 60 s) is an important warm-up component considering its potential to positively impact flexibility and prevent musculotendinous (MT) injury without significant negative effects on muscle power and strength performance (Chaabene et al., 2019), which has previously been a point of contention among researchers.

Control

It was estimated that the treatments would last approximately 10 min considering instruction, demonstrations, and exercise duration. Therefore, participants assigned to the CON group sat comfortably in a chair for 10 min immediately following their ROM pretest and prior to their ROM posttest as this study recognized possible testing effects of the MSR procedure on hamstrings ROM.

Statistical Analyses

Following data collection, mean hamstrings ROM scores were computed for each participant by averaging the three MSR attempt scores for the ROM pre- and posttests to yield pre- and post-intervention or CON condition means. These averages were then used to calculate group mean ROM pre- and posttest scores that were used to compute percent changes. A two-way (group x time) repeated measures analysis of variance (ANOVA) was used to analyze group, time, and interaction effects. Using mean difference scores (calculated as group mean ROM posttest - group mean ROM pretest), a one-way ANOVA was used to assess between group differences in ROM changes from pre- to post-intervention or CON condition. The level of significance was set at 0.05 ($\alpha = 0.05$) and data are presented as mean ± standard deviation. All statistical analysis procedures were performed using SuperAnova (Abacus Concepts Inc., Berkeley, CA).

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RESULTS

A total of 36 university students completed the study. Group allocation and participant characteristics are described in the following: 12 participants were allocated to the FR group (female, *n* = 7; male, *n* = 5; age, 21.58 ± 3.06 yr; height, 172.22 ± 12.03 cm; weight, 164.22 ± 41.80 lb; ROM screening score, 15.16 ± 3.29 in), 13 participants were allocated to the SS group (female, *n* = 7; male, *n* = 6; age, 22.08 ± 2.25 yr; height, 171.06 ± 8.31 cm; weight, 168.75 ± 27.21 lb; ROM screening score, 14.68 ± 3.41 in), and 11 participants were allocated to the CON group (female, *n* = 6; male, *n* = 5; age, 21.82 ± 2.32 yr; height, 168.84 ± 8.97 cm; weight, 158.75 ± 34.42 lb; ROM screening score, 15.64 ± 3.10 in).

Acute Changes in Hamstrings ROM

Descriptive statistics and mean percent changes between the two time points for each group can be viewed in Table 1.

Table 1

Pre- and Post-intervention Mean Hamstrings ROM Scores and Percent Changes

	Pretest	Posttest	
Group	*M(SD)*	*M(SD)*	% Change
CON	14.56(3.10)	15.46(3.16)	6.16
SS	13.18(3.16)	14.42(3.45)	9.39
FR	14.01(2.75)	15.66(2.76)	11.77

Note. ROM scores are presented in inches.

Results from the two-way repeated measures ANOVA revealed a statistically significant main effect of time but no group or group x time effects (see Table 2 for *p* values), indicating significant improvements in hamstrings ROM in all groups with no significant differences between groups and between groups over time from pre- to post-intervention.

Table 2

Two-way Repeated Measures ANOVA Summary Table

Source	*SS*	*df*	*MS*	*F*	*p*
Group	21.23	2	10.62	0.57	0.572
Time	28.51	1	28.51	94.19	< 0.001*
Group x Time	1.63	2	0.82	2.7	0.082

*$p < 0.05$.

Compared to the CON, further contrasts revealed a statistically significant difference in the SS group mean ROM score at pretest, $F(1, 22) = 37.76$, $p < 0.001$, and posttest, $F(1, 22) = 21.52$, $p < 0.001$, and a statistically significant difference in the FR group mean ROM score at pretest, $F(1, 21) = 5.89$, $p = 0.021$, but not at posttest, $F(1, 21) = 0.72$, $p = 0.404$, indicating that the SS group mean ROM score was significantly lower than the CON at the pre- and post-intervention time points while the FR group mean ROM score was significantly lower than the CON at the pre-intervention time point but was similar post-intervention. Figure 1 provides a graphical representation of group mean contrasts and depicts general data trends.

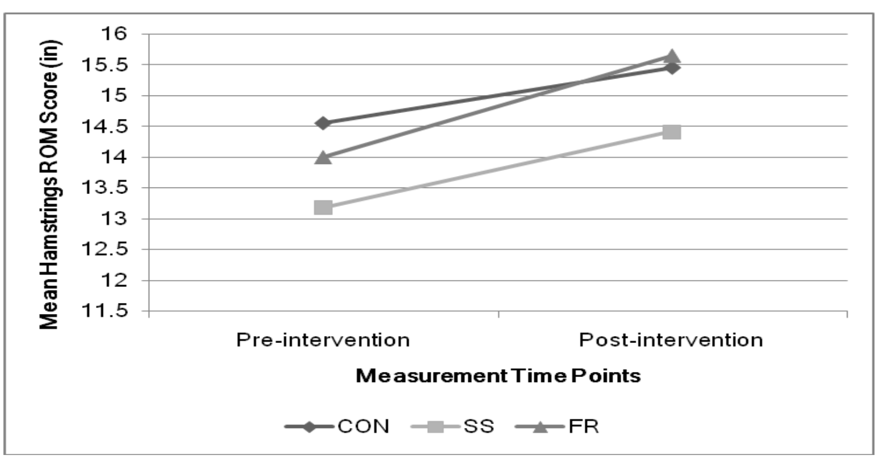

Figure 1. *Mean Changes in Hamstrings ROM Scores*

Results from the follow-up one-way ANOVA revealed a statistically significant difference in ROM changes (i.e., mean difference scores) between FR and CON, $F(1, 21) = 5.36$, $p = 0.027$, but not SS and CON, $F(1, 22) = 1.13$, $p = 0.295$, or SS and FR, $F(1, 23) = 1.75$, $p = 0.195$, indicating that the FR group mean ROM score increased significantly greater than the CON mean score while the improvements in group mean ROM scores were similar when comparing SS vs. CON and SS vs. FR from pre- to post-intervention.

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DISCUSSION

This study sought to compare the acute effects of SMR (via FR) and SS on hamstrings ROM. The salient findings were (a) short bouts of SS and FR (4 min total, 30 s x 8 exercises) were sufficient to elicit acute improvements in hamstrings ROM, (b) compared to CON, these improvements were significantly greater only after FR, and (c) when comparing experimental groups, ROM improvements were similar. These findings partially support the original hypothesis.

Static Stretching and Foam Rolling Improve ROM

Evidenced by a significant main effect of time, the finding that SS and FR both led to improvements in hamstrings ROM from pre- to post-intervention is in line with the original hypothesis. SS has long been recognized as a primary modality for chronically increasing muscle extensibility and joint ROM, but acute enhancements can also be garnered by performing short-duration (≤ 60 s) SS. In fact, the dose-response relationship may be similar in short-duration SS as no significant differences between 30 and 60 s have been reported for hip and knee range of motion (Cini et al., 2017). Neurological mechanisms can be partially implicated in these improvements as acute MT unit lengthening modulates the activity of central and peripheral reflexes which can reduce passive muscle tension. This decreased tension results in increased range of motion (Guissard & Duchateau, 2006). At the same time, static stretch durations of 15 and 60 s have been shown to be ineffective in eliciting adaptations to the mechano-morphological properties of MT units in the lower extremities (Stafilidis & Tilp, 2015). The SS group stretch performance observed in this study is consistent with the extant literature and can likely be partly attributed to the mechanisms highlighted above.

Similarly, acute enhancements in flexibility have also been demonstrated following the performance of various SMR exercises such as FR. For example, in the study from which the FR technique employed in the present study was adapted, MacDonald et al. (2013) found an acute bout of quadriceps SMR effective at enhancing knee joint ROM absent muscle performance deficits. Participants were evaluated on quadriceps force and activation variables as well as knee joint ROM before and after performing one of two study conditions (2, 1 min trials of quadriceps FR or CON).

Particularly important were the significant ROM enhancements at both 2 and 10 min post-intervention in the SMR group. The results of the present study support and further those reported by MacDonald et al. (2013). They validate the efficacy of this FR technique and extend its effectiveness to hamstrings ROM with a shorter protocol duration (2, 1 min trials vs. 1, 30 s trial per muscle group). Other studies have since reported similar acute effects on ROM that appear to be transient (e.g., Smith et al., 2018), and these effects likely result from the mechanisms previously outlined.

Significantly Greater Improvements after FR vs. CON

Group mean comparisons at both time points indicated that ROM improvements were significantly greater after FR but not SS when compared to CON. This observation was confirmed upon further analysis of difference scores where ROM changes (posttest – pretest) were significantly different only between FR and CON and not SS and CON. This finding partially supports the original hypothesis that both FR and SS would result in significant improvements in hamstrings ROM over the CON. However, the SS group's comparatively smaller ROM change is likely the result of the testing modality and not a question of SS's effectiveness in improving flexibility. This conclusion is based on the CON group's significant improvement in hamstrings ROM from pre- to posttest.

It is improbable that the MSR procedure led to any real improvements in hamstrings extensibility (i.e., muscle lengthening). However, the testing effect observed in the CON group may be a result of participants' increased ability to withstand greater stretching forces during the ROM posttest given that SS can elicit ROM enhancements due to improved stretch tolerance (Page, 2012) and that the MSR pretest somewhat mimicked a short-duration static stretch, albeit intermittent. This study acknowledges the fact that all ROM improvements would have been smaller absent any testing effects, but it is assumed that both treatment groups would have maintained significant improvements from pre- to post-intervention regardless of these effects as other FR (MacDonald et al., 2013) and SS (DePino et al., 2000) studies have demonstrated improvements determined by other assessment methods with expectedly lesser testing effects. In other words, without the testing effect observed in the CON—which likely reflects improved stretch tolerance resulting from the MSR pretest trials—the SS group mean ROM improvement would have been significantly greater compared to CON. Without testing effects in any group, FR and SS would still be expected to result in significant ROM improvements over CON considering the extant literature.

Similar ROM Improvements Between SS and FR

Follow-up analysis of group mean ROM changes between SS and FR indicated similar improvements in hamstrings ROM consequent to the interventions. While a general trend of greater improvement in the FR group was observed (11.77% increase in FR vs. 9.39% in SS), this did not reach statistical significance when compared to the SS group. This finding does not support the original hypothesis and contradicts what has previously been reported in research comparing the effectiveness of SS and FR on acute muscle flexibility.

Su et al. (2017) concluded that FR was more effective than SS for acutely enhancing flexibility in the hamstrings and quadriceps. Interestingly, their protocol consisted of 90 s total (3, 30 s exercises) of FR or SS per muscle group compared to this study's 30 s total (1, 30 s exercise) per muscle group. Taken together, these findings point to a possible dose-response relationship. It is not until longer durations of SS and FR that significant differences occur between the treatments. This suggests that FR and SS performed for short-durations are equally efficacious for acute improvements in hamstrings ROM while additional benefits may occur because of longer duration FR compared to SS.

Limitations

Although this study had numerous strengths, limitations were also present. The salient limitation identified was the use of the MSR procedure as a hamstrings ROM screening test. Without additional modifications, the MSR procedure yields a composite hamstrings ROM score from three stretch trials. In this study, these scores were used to rank participants before group allocation in an effort to ensure similar mean hamstrings ROM between groups at baseline. However, analysis of ROM pretest scores indicated that group mean hamstrings ROM was significantly different between groups at baseline. It is therefore likely that three MSR trials are not sufficient to establish a true baseline hamstrings ROM score. Considering this and ROM differences observed from screening test to pretest, additional trials should have be added to the

MSR procedure or an alternative assessment method should have been used when establishing baseline values for hamstrings extensibility.

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CONCLUSION

Overall, the results of this study show that short-duration (30 s per muscle group) SS and FR have similar positive effects on acute hamstrings ROM. These findings have practical relevance as they highlight the effectiveness of a FR protocol similar in duration to SS recommendations made on the basis of flexibility improvements and MT injury prevention without concomitant reductions in strength and power performance. Given that FR for longer durations has been demonstrated to enhance ROM without muscle performance deficits (MacDonald et al., 2013), similar ROM improvements between short-duration SS and FR in the present study suggest that FR exists as a viable alternative or adjunct to SS as part of a precompetitive warm-up to garner ROM enhancements without hindering performance; this has clear implications. It should be noted, however, that this study examined only the effects of FR and SS on acute hamstrings ROM changes and not on MT units directly. Thus, more research is needed to further elucidate the mechanism(s) by which these techniques—particularly SMR techniques—exert their effects on MT units at the tissue level.

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Bachelor of Science, Exercise Science, August 2018

Research Paper Title:
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