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Original Research

The Effects of an Acute Bout of Self-Myofascial Release on the Physiological Parameters of Running

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ABSTRACT

International Journal of Exercise Science 13(3): 113-122, 2020. This study examined changes in the physiological parameters of running performance when self-myofascial release (SMR) was used prior to a submaximal run. A total of 16 male recreational runners, between the ages of 27 and 50 years old volunteered for the study. Participants had to complete a running event measuring a 10K or longer in the past 12 months and obtained a $\dot{V}O_{2\text{peak}}$ value of $45 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ to be included in the study. Participants took part in two 40 min treadmill runs at 75% of their $\dot{V}O_{2\text{peak}}$, one session with the use of SMR and the other with 20 min of seated rest prior to the run. Measurements of heart rate, blood lactate concentrations, ventilatory efficiency ($\dot{V}E / \dot{V}O_2$), RPE, and running velocity were assessed. There was no statistically significant interaction or treatment effect for these variables when SMR was used prior to a 40 min treadmill run ($p > .05$; heart rate: $d = .01$, $\dot{V}E / \dot{V}O_2$: $d = .07$, RPE: $d = .07$). Although no positive effects on running performance were found, the lack of negative effects suggests the use of SMR prior to running does not hinder performance.

KEY WORDS: Manual therapy, aerobic exercise, performance, acute bout

INTRODUCTION

Manual therapies such as sport massage is used to help prepare an athlete for competition, enhance athletic performance, improve recovery, and is used as an intervention for sports-related musculoskeletal injuries (9). The increased use of sport massage among recreational and professional athletes has led to the development of self-myofascial release (SMR) tools by numerous companies. SMR is implemented with tools such as foam rollers, roller massagers or other similar devices (4). These tools have also grown in popularity yet there is limited evidence as to their effects on the physiological and mechanical factors of human movement. Many of the studies examining SMR prior to exercise focus on measures of flexibility, muscular strength, power, and sprinting performance. These studies have demonstrated conflicting results (7, 10,

12, 14, 15, 17, 21, 25, 30). There have been limited studies examining the use of tool assisted SMR prior to submaximal endurance exercise.

Maximal oxygen consumption ($\dot{V}O_{2max}$), lactate threshold, and running economy are predictors of successful running performance during endurance events (19). The goal for an endurance runner is to sustain a high percentage of $\dot{V}O_{2max}$ while still being able to clear lactate at the same rate of accumulation. Running economy is the energy demand needed to maintain a steady state running velocity and tends to be affected by the runner's mechanical efficiency. Runners who have a high mechanical efficiency will use less energy during a submaximal run and remain below their lactate threshold for longer periods of time. Running efficiency is influenced by range of motion of the knee, hip, and ankle which affects runners' stride mechanics. Greater flexibility and decrease in muscular adhesions have been found to increase running economy and speed. However, there may be an optimal flexibility needed in the legs since muscle stiffness is also a determinant of running economy (13, 26). An increase in oxygen consumption of 30 to 40% would occur if elastic energy, storage, and return were not contributing to the mechanics of running (33). A decrease in oxygen consumption of the respiratory muscle has also been found to improve running economy. Reducing breathing frequency and increasing tidal volume may lower the aerobic demands of submaximal running (13, 26).

There are numerous studies which examine interventions that hope to improve a runners' mechanical and physiological efficiency. There seem to be conflicting results on the use of stretching prior to running. Early studies in which examined static stretching prior to a running event found a decrease in running economy and performance, the researchers hypothesized that leg stiffness is needed for propulsion forward (14, 26). More recently, researchers found that static stretching did not affect submaximal oxygen cost or running economy. There were changes in the neuromuscular performance of the running muscles, but these changes were not detrimental to running speed or economy (1, 9, 16, 26, 34). SMR and therapist applied massage have also been found to significantly improve joint range of motion in the lower extremities, hamstrings, knee joint and hips (3, 5, 24, 33). Research examining massage and the effects on muscle tissues also present conflicting results. Researchers have found massage to stimulate the Golgi Tendon organ reflex and reduce the motor unit firing rate decreasing muscle tension. The pressure applied during manual therapy has been found to inhibit the H-Reflex (an indirect measure of alpha motor neuron excitability) and decrease electromyography (EMG) activity (4). While other studies found a decrease in muscular strength and endurance with the use of manual therapy prior to exercise. However, there is an increasing amount of evidence that SMR can increase range of motion without being detrimental to exercise performance (5, 11, 21, 30, 32, 34).

$\dot{V}O_{2max}$ is a measure of the body's ability to deliver oxygen to the muscles during exercise as well as the maximal ability of that muscle to extract the oxygen from blood. Increasing perfusion to the active muscle tissue will increase blood flow to the capillaries allowing for greater oxygen extraction by the muscle tissue. Therefore, methods of improving blood flow may be advantageous for endurance athletes. Both therapist assisted massage and SMR have been examined to determine their ability to improve blood flow. At rest massage has been found to

increase oxygen consumption and blood flow, likely due to an increase venous return. Massage may also increase cardiac output and decrease heart rate (7, 20, 27). Recently, the effects of SMR on blood flow have been examined. Hotfiel et al. (18) found arterial perfusion increased at the lateral thigh and remained so after 30 minutes following a bout of SMR. Increased tissue circulation was believed to increase the temperature of the muscle. Other studies have also found improved arterial function with the use of SMR noting an improvement in endothelial function during resting conditions (29). An increase in blood flow may also aid with the removal of lactate during and after exercise. Again, there seems to be conflicting evidence as to the effectiveness of manual therapy interventions. Praestyol and Elyana (31) found that friction massage is beneficial in removing lactate post exercise whereas other researchers did not see improvements in lactate concentrations with the use of therapy assisted massage or SMR (8, 36). When examining submaximal running performance as a whole Boone, Cooper and Thompson (5) did not report any improvements in performance when sports massage was used prior to the run. The only other study found to examined submaximal running and manual therapy was conducted by Wilson, Hornbuckle and Kim (35) measured the energy cost of a submaximal run after SMR. They found that the energy cost of running increased with the use of SMR.

There is limited evidence as to the use of SMR prior to submaximal endurance events. The SMR literature focuses mainly on short duration, anaerobic activities and range of motion. These studies have not examined the physiological parameters of running performance. Therefore, the purpose of this study was to examine running performance when SMR tools were used prior to an acute bout of submaximal running. Heart rate, running velocity, blood lactate, ventilatory efficiency and rate of perceived exertion were examined. Heart rate, blood lactate, and rate of perceived exertion were expected to decrease with the use of SMR. Running velocity and ventilatory efficiency were expected to increase with the use of SMR.

METHODS

Participants

A power analysis (G*Power, Heinrich-Heine-Universität Düsseldorf) was run to determine sample size for the study, to obtain a Beta equal to .80, with a moderate effect size of .25, at least 20 subjects were needed. Twenty recreational runners volunteered for the study and sixteen subjects completed all testing sessions (age 36.56 ± 6.5 , body fat percent 15.43 ± 5.04 , $\dot{V}O_{2\text{peak}}$ $53.29 \pm 7.27 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$). The subjects were recruited from local running and triathlon clubs in New England. Participants were asked to report the number of days and miles they run per week (days run per week, $3.8 \pm .75$; miles run per week, 24.8 ± 9.0). To be included in the study, participants needed to complete a running event of 10 kilometers or longer in the past 12 months, as well as obtain a $\dot{V}O_{2\text{peak}}$ value of $45 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. $\dot{V}O_{2\text{peak}}$ was determined by the McConnell Protocol (23) utilizing a Physio-Dyne II Max metabolic cart (Physio-dyne Instrument Corporation, Quogue, NY). $\dot{V}O_{2\text{peak}}$ was obtained when any of the following criteria were met: volitional fatigue, an RER of 1.2 or higher, heart rate greater than 95% of predicted maximum, and/or $\dot{V}O_2$ remaining constant as workload increases.

The participants completed an informed consent, a medical history, and training history questionnaire when they arrived at the lab for the first session. Participants were excluded from the study if they had any serious medical conditions and/or any current musculoskeletal injuries. The college's Institutional Review Board approved all methods and procedures prior to data collection. Participants were asked to refrain from vigorous exercise, caffeine and alcohol 24 hours prior to all experimental sessions. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science. (28)

Protocol

The physiological variables examined in this study were heart rate, running velocity at 75% of $\dot{V}O_{2peak}$, blood lactate, ventilatory efficiency and rate of perceived exertion. The variables were selected because of their relationship to endurance running performance (19). Participants reported to the lab for 3 sessions in total. During the first session the participants completed the necessary paperwork and performed the $\dot{V}O_{2peak}$ test. The participants had their weight measured and body fat percentage estimated using the Bod Pod. The peak test was then performed and the participants who met the criteria received a tutorial on the SMR protocol. Participants were randomly assigned to either passive rest or SMR prior to their first running session.

During the session with the SMR intervention participants led themselves through the Trigger Point Ultimate 6 Kit with the help of the instruction manual and feedback from the researcher. This kit was applied to the soleus, quadriceps, iliotibial band, piriformis, iliopsoas, and pectoral muscles on both sides of the body. Participants were instructed to roll to the point where they felt pressure on each muscle group but not to the point of pain. Detailed instructions of the protocol can be found by referring to the Ultimate 6 Kit instruction manual. The amount of pressure used is self-selected by the individual. This protocol, on average, took 20 min to perform. During the control session participants sat quietly in a chair for 20 min in the human performance lab prior to the treadmill run.

When the participants arrived at the lab for the experimental session, a resting blood lactate measure was acquired to establish a baseline value. All measures of blood lactate were obtained via capillary puncture and analyzed by the Accutrend Lactate Analyzer (Roche Diagnostics Ltd, North America). Immediately following the seated rest or SMR participants were set up on the metabolic cart while standing on the treadmill. Before the treadmill run began measurements of heart rate, oxygen consumption, tidal volume, blood lactate and RPE were taken while participants stood on the treadmill. Oxygen consumption, respiratory exchange ratio, tidal volume, and $\dot{V}O_{2peak}$ were analyzed using open circuit spirometry (Physio-dyne Max II, Physio-dyne Instrument Corporation, 141-A, Quogue, NY). Heart rate was measured using a heart rate monitor (Garmin Forerunner, Model 910 XT, Olathe, KS) and RPE was measured by the modified Borg scale (6). Once the baseline values were obtained, participants warmed up by gradually increasing the treadmill speed from a walk to a running at 75% of their $\dot{V}O_{2peak}$ and this intensity was held for the duration of the 40 min run. Speed on the treadmill was adjusted if participants were not maintaining 75% of their $\dot{V}O_{2peak}$ during the run, oxygen consumption data was continuously monitored by the research assistants and metabolic cart to ensure they

stayed as close as possible to this intensity. Running velocity was measured by recording the current treadmill speed at each data collection time point. Heart rate, $\dot{V}O_2$, blood lactate, RPE, ventilatory efficiency ($\dot{V}E/ \dot{V}O_2$), and running velocity were recorded at minutes 0, 10, 20, 20, 30 and 40 (end of run).

Statistical Analysis

This study examined the effects of self-myofascial release on the physiological parameters of running performance using a within participants design. Statistical analyses were performed using IBM SPSS (Version 25). Statistical significance was set at $p < .05$. Three 2×5 (intervention \times time) repeated measures analyses of variance (ANOVA) analyzed the dependent variables of heart rate, $\dot{V}E/ \dot{V}O_2$, and RPE. One 2×6 ANOVA (intervention \times time) analyzed the dependent variable of blood lactate since an additional data point was collected for this variable when the subjects arrived at the lab. If an interaction was significant a simple effects Tukey post hoc analysis was performed. One paired samples t-test analyzed the dependent variable of running velocity at 75% of $\dot{V}O_{2peak}$. Mauchly's Test of Sphericity was used to determine if the basic assumptions for repeated measures independent variables was met. For all variables where Mauchly's Test of Sphericity was significant ($p < .05$) the Greenhouse Geisser was used to adjust the degrees of freedom. All data used mean \pm SD.

RESULTS

A post hoc power analysis was conducted to determine power for the study with the use of sixteen subjects. For the 2×5 RM ANOVA power was equal to .67, for the 2×6 RM ANOVA power was .69, and for the paired samples t-test was .60.

A series of three 2×5 repeated measures ANOVAs examined the dependent variables of heart rate, $\dot{V}E/ \dot{V}O_2$, and RPE for condition and time. There were no statistically significant interactions ($p > .05$) between intervention and time for heart rate ($F_{4,60} = 0.21$), $\dot{V}E/ \dot{V}O_2$ ($F_{4,60} = 1.11$) and RPE ($F_{4,60} = 1.09$). The Cohen's effect size value (heart rate: $d = .01$, $\dot{V}E/ \dot{V}O_2$: $d = .07$, RPE: $d = .07$) for all three of these variables suggested a low practical significance. The main effect, time, was statistically significant ($p < .05$) for heart rate ($F_{4,60} = 594.47$), $\dot{V}E/ \dot{V}O_2$ ($F_{4,60} = 26.10$) and RPE ($F_{4,60} = 231.20$). The Tukey post hoc analysis found that during the 40 min an increase in heart rate, $\dot{V}E/ \dot{V}O_2$, and RPE occurred. The Cohen's effect size value for heart rate, $\dot{V}E/ \dot{V}O_2$ and RPE suggested high practical significance (heart rate: $d = .98$, $\dot{V}E/ \dot{V}O_2$: $d = .64$, RPE: $d = .94$). A statistically significant main effect for the condition ($p < .05$) was found for heart rate ($F_{1,15} = 7.25$) however, a post hoc analysis found no statistically significant differences ($p > .05$). (Table 1,2) Cohen's effect size value ($d = .33$) suggested a low to moderate practical significance.

Table 1. Means (standard deviations) for Ventilatory Efficiency, Heart Rate, and RPE when using self-myofascial release prior to a 40-min treadmill run.

	$\dot{V}_e / \dot{V}O_2$	Heart Rate (bpm)	RPE
Time 1 (PreRun)	33.2 (7.3)	66.1 (12.7)	0.0 (0.0)
Time 2 (10 min)	24.5 (2.1)	152.2 (12.4)	3.5 (0.8)
Time 3 (20 min)	24.8 (2.2)	155.9 (14.0)	3.8 (0.7)
Time 4 (30 min)	22.9 (8.1)	160.1 (13.1)	3.9 (0.9)
Time 5 (40 min)	25.2 (2.4)	162.3 (12.7)	4.1 (0.9)

Note: $\dot{V}_e / \dot{V}O_2$ = Ventilatory efficiency; RPE = Rate of Perceived Exertion using the 10-point Borg Scale

Table 2. Means (standard deviations) for ventilatory efficiency, heart rate, and RPE with no self-myofascial release prior to a 40-min treadmill run.

	$\dot{V}_e / \dot{V}O_2$	Heart Rate (bpm)	RPE
Time 1 (PreRun)	32.0 (5.1)	68.3 (12.7)	0.0 (0.0)
Time 2 (10 min)	24.6 (2.9)	153.7 (12.6)	3.9 (1.4)
Time 3 (20 min)	24.9 (2.7)	159.1 (12.8)	4.2 (1.6)
Time 4 (30 min)	24.0 (3.0)	161.8 (12.2)	4.5 (1.6)
Time 5 (40 min)	25.3 (2.8)	164.8 (13.5)	4.5 (1.5)

Note: $\dot{V}_e / \dot{V}O_2$ = Ventilatory efficiency; RPE = Rate of Perceived Exertion using the 10-point Borg Scale

A 2 x 6 repeated measures ANOVA was performed for the dependent variable of lactate. No statistically significant ($F_{3,04,75} = 0.96, p > .05$) interaction or treatment effect was found between the intervention and time points for lactate. Cohen’s effect size value ($d = .06$) suggested a low practical significance. A statistically significant time factor ($F_{5,75} = 12.07, p < .05$) was found for lactate. The Tukey post hoc analysis found that during the 40 min an increase in lactate occurred (Table 3). Further, Cohen’s effect size value ($d = .45$) suggested a moderate practical significance.

Table 3. Means (standard deviations) for blood lactation with and without the use of self-myofascial release (SMR) to no self-myofascial release prior to a 40 Minute treadmill run.

	Lactate (mmol/L) SMR	Lactate (mmol/L) No SMR
Time 1 (Baseline)	2.8 (0.9)	2.6 (0.6)
Time 2 (PreRun)	2.6 (0.6)	2.7 (0.6)
Time 3 (10 min)	3.4 (1.0)	3.4 (1.1)
Time 4 (20 min)	3.4 (1.1)	3.7 (1.1)
Time 5 (30 min)	3.6 (1.0)	3.7 (1.1)
Time 6 (40 min)	3.4 (0.7)	3.8 (1.4)

A paired samples t-test was used to analyze the differences in running velocity and treatment condition (SMT vs. No SMT). The participants’ running velocity was recorded throughout the run, and any changes in velocity were noted. The running velocity was then averaged over the 40 min run. The mean velocity for the run with no SMT was 12.47 kmh ± 1.70. The mean velocity for the run with SMT was 12.57 mph ± 1.69. No statistically significant differences existed between the two running bouts ($t_{15} = -.838, p > .05$).

DISCUSSION

The purpose of this study was to determine whether SMR could be used prior to a 40 min submaximal run without decreasing performance. Heart rate, running velocity, blood lactate, $\dot{V}E/ \dot{V}O_2$, and RPE were the physiological parameters used to determine changes in running performance. No improvements in these parameters were found when SMR was utilized. There were also no changes in running velocity with the use of SMR. Changes which occurred in heart rate, RPE, $\dot{V}E/ \dot{V}O_2$ and blood lactate concentration during the run reflected normal physiological responses to exercise. This study supports previous research which also did not find improvements in performance when SMR tools were used prior to an exercise session (10, 15, 16, 24, 33). Many of these studies utilized strength and power testing as opposed to endurance exercise. There is limited information on the effects of SMR when used prior to a bout of submaximal endurance exercise.

For a decrease in heart rate to occur, the SMR tool would need to influence the neural and hormonal mechanisms of cardiovascular functioning. Hotfiel et al. (18) found foam rolling increased blood flow to the lateral thigh. An increase in blood flow could reduce heart rate by increasing venous return. The current study supports Boone et al. (5) who also reported no change in heart rate when massage was used prior to a submaximal run. There were also no changes in lactate concentrations which is likely due to the participants being held at 75% of their $\dot{V}O_{2peak}$. Maintaining steady state intensity for 40 min may have resulted in lactate production equaling clearance (15). Lactate was a beneficial variable to measure since it ensured that the subjects were being held at a submaximal running velocity. A lack of differences in lactate concentrations supports previous studies that examined the use of manual therapy to clear lactate these studies used anaerobic exercise that would induce higher lactate levels. (8,36) To determine if pre-exercise SMR would affect lactate concentrations a run that is performed close to lactate threshold may be needed.

No changes in $\dot{V}E/ \dot{V}O_2$ were found. The developers of the Trigger Point Therapy kit used in this study advises SMR be performed on the pectoral muscles to reduce tension, rotate the shoulders back to improve posture. Since the pectoral muscles are used during heavy breathing this advice could have merit. Increasing tidal volume and ventilatory efficiency has been found to improve running economy and performance (33) however in this study no changes in $\dot{V}E/ \dot{V}O_2$ were found. More than likely SMR did not affect the accessory inspiratory muscles which are responsible for increasing tidal volume. $\dot{V}E/ \dot{V}O_2$ also depends on lung compliance and the internal resistance of the pulmonary tissues and SMR would not be able to impact these parameters.

Baxter et al. (4) suggests that endurance runners avoid static stretching during their warm-up and seek out other methods that do not decrease mechanical efficiency. Although there is conflicting evidence as to whether static stretching decreases running performance (4, 9, 14, 16, 25), SMR may be attractive to athletes as an alternative to static stretching. SMR may act as a warm-up by increasing blood flow and preparing the athlete for competition (17, 30). Two recent

studies found that when individuals used SMR combined with dynamic stretching improvements in power, agility, strength and speed were observed (30, 31). Richman et al. (32) found that SMR plus dynamic stretching improved ROM with no detriment to performance. Running velocity and the cost of running is dependent upon biomechanical factors such as vertical motion, stride mechanics, ground reaction forces and flexibility. In this study changes in running performance were not observed and may be a result of the numerous factors which must work concurrently to improve running performance. An acute bout of SMR may have not been enough to alter these parameters. Future research is needed to examine the changes in biomechanics that may occur with both the acute and chronic use of SMR prior to running.

The psychological effects of using SMR were not measured but should be examined in the future. Athletes may believe using an SMR tool prior to competition will be beneficial to their performance. Further research is needed to determine if improvements in perceived effort are a result of physiological improvements or a psychological response. The researchers acknowledge that the study has limitations. The pressure elicited by the SMR tool was self-selected. The researcher also did not control for prior experience with SMR, some of the participants had used SMR tools in the past while others had not.

Although no improvements in running performance were found there were also no decreases in performance. This contrasts with the study performed by Wilson et al. (35) Which found that the use of SMR increase the cost of submaximal running. Our study is in support of previous literature that states no decreases in performance occurred with pre-performance SMR (12, 21, 34). In the current study the participants were able to run at an intensity equaling 75% of their $\dot{V}O_{2peak}$ without eliciting negative changes in performance supporting Beardsley and Skarabot's (4) statement that SMR does not need to be avoided prior to exercise. In conclusion, an acute bout of SMR did not improve nor hinder the physiological parameters of running performance. Few studies have examined the use of pre-exercise manual therapy on endurance exercise. This study adds to the growing body of research on SMR and its effects on performance.

Since no decreases in performances occurred, the results of this study suggest that there should be no negative effects if an athlete enjoys using SMR tools as a part of pre-competition preparation. However, further research is needed to confirm these results as well as to determine the physiological and biomechanical mechanisms that SMR may affect with its use.

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