THE EFFECTS OF COMPRESSION SOCKS ON PERCEPTION OF POST EXERCISE MUSCLE SORENESS

by

Friederike Feil

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This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Michael Whitehurst, Department of Exercise Science and Health Promotion, and has been approved by the members of his supervisory committee. It will be submitted to the faculty of the College of Education and will be accepted in partial fulfillment of the requirements for the degree of Master of Science.

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ABSTRACT

Author:	Friederike Feil
Title:	The Effects of Compression Socks on the Perception of Post Exercise Muscle Soreness
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Purpose: To evaluate the influence of compression socks worn post exercise on the perceived rating of muscle soreness. **Methods:** In a randomly cross over design, 16 subjects performed a soreness inducing protocol. Below knee CG (Compression garments) were worn for the next 6 hours post exercise. HR (Heart Rate), RPE (rate of perceived exhaustion) and time to complete one cycle was measured throughout the intervention. PS (Perceived Soreness) was assessed prior, immediate post, 6h, and 24h post exercise. **Results:** There was no significant difference in perception of soreness between compression and no compression at 6h post exercise (p=.136) and at 24h post exercise (p=286). **Conclusion:** Compression socks worn post exercise did not significantly alter ratings of perceived soreness after a soreness inducing protocol.

THE EFFECTS OF COMPRESSION SOCKS ON THE PERCEPTION OF POST EXERCISE MUSCLE SORENESS

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Chapter 1: Introduction

Although the use of compression garments (CG) emerged in clinical settings in the 1950's, their origin dates back to the time of the Egyptians (Hsiu-Fang & Feng-Ping, 2005). Compression was used then and today as a means of addressing circulatory insufficiency, thromboembolism and fatigue precipitated by standing relatively motionless for long periods of time (Agu, Hamilton, & Baker, 1999; Prandoni et al., 2004). More recently, the use of CG has shifted to athletics (Scanlan, Dascombe, Reaburn, & Osborne, 2008). Based on anecdotal evidence, endurance athletes (e.g. cyclists) appear to have started to use CG in an attempt to enhance performance and/or hasten recovery (Chatard et al., 2004; Kemmler, Kockritz, Mayhew, Wasserman, & Zapf, 2009).

The compression in CG today is graduated with the greatest pressure felt at the distal segment (normally the ankle) and the least pressure occurring at the largest body segment (Ali, Caine, & Snow, 2007). As such, compression appears to reduce the cross sectional area (CSA) of body segments (Buhs, Bendick, & Glover, 1999), suggesting an improved venous return and better circulatory dynamics; whereas, arterial circulation may benefit from compression by actually increasing the diameter of the arteries via the myogenic mechanism (Bochmann et al., 2005). Hence, the larger diameter wall would promote circulation and the transport/utilization of nutrients and oxygen.

Given the potential to improve vascular dynamics, CG seem to be a viable device to reduce muscle damage and hasten recovery. Specifically, strenuous exercise disrupts the cytoskeleton (Clarkson, 2002) and initiates a cascade of innate/inflammatory actions (Chatzinikolaou et al., 2010) usually triggering delayed onset muscle soreness (DOMS).

Although the role of CG in ameliorating muscle damage/soreness is far from elucidated, Kraemer, Volek, & Bush, (2000) suggested that compression may help stabilize and maintain the orientation of the muscle fibers and therefore, reduce the pro-inflammatory response. Unfortunately, only a few studies have attempted to study the role of CG on muscle soreness precipitated by exercise (Manfredi et al., 1991; Sorichter et al., 1997). Furthermore, these studies are plagued by methodological issues, including studying damage in sports-related environments and adequately controlling for exercise dosage, particularly intensity. Finally, several reports of decreased DOMS exist resulting from the use of CG during a road race and during the 24 hours following a soreness inducing exercise protocol (Chatard et al., 2004; Ali et al., 2007). Considering the available evidence, it is difficult to predict whether compression can reduce exercise-induced muscle damage and subsequent soreness.

Purpose

Given the potential problems with exercise dosage and the general lack of information concerning the effects of CG on post-exercise muscle damage/soreness, it seemed prudent to devise a study that held exercise dosage constant and to apply compression for a period immediately following exercise during which muscle damage and soreness was thought to peak. Therefore, the purpose of this study was to evaluate

the effect of 6 hours of post-exercise compression on skeletal muscle soreness as elicited by a controlled muscle damage/soreness inducing exercise protocol.

Hypothesis

Below knee compression socks, worn for 6 hours immediately following a skeletal muscle damage/soreness inducing exercise protocol will significantly reduce participants rating of perceived soreness.

Chapter 2: Literature Review

This literature review focused on the use of compression socks in non-athletic settings and athletic settings as a means of reducing muscle damage and soreness.

Compression Socks in Non-athletic Settings

Compression socks/garments (CG) were originally used in clinical settings to prevent the development of deep venous thromboembolism (DVT). Agu et al. (1999) and Mayrovitz (2010) reported compression improved venous function and reduced the incidence of DVT by as much as 70% in patients presenting circulatory insufficiency. Preventing DVT is of utmost importance given a series of DVTs can lead to post thrombotic syndrome, pulmonary embolism and death. Even in those patients with a diagnosis of DVT, chronic use of compression socks has reduced the risk of developing post-thrombotic syndrome (Sigel, Edelstein, Savitch, Hasty, & Felix, 1975; Prandoni et al., 2004). Thus, the vascular dynamics associated with post-thrombotic syndrome, including vessel wall compromise, altered blood flow, and mutation of blood properties may be managed with the use of compression socks (López & Chen, 2009; Ahmadi, Sinclair, & Davis, 2008; Zhang, Yeung, Allen Qin, & Yeung, 2008; Khalsa, 2004).

Frequent air travelers show similar symptoms which alter blood flow and the mutation of blood properties (Hsiu-Fang & Feng-Ping, 2005; Weiss & Duffy, 1999). Symptoms, including stiffness, swelling, leg pain or leg discomfort, increased with the length of the flight (Hsiu-Fang & Feng-Ping, 2005). Since the post-thrombotic syndrome in air travelers was considered a preventative disease, many researchers, as well as the World Health Organization, started to investigate the influences of compression socks on air travelers (Hsiu-Fang & Feng-Ping, 2005). For example, Weiss and Duffy (1999) evaluated the use of light weight, low-compression hosiery in 19 flight attendants. He observed the flight attendants over a period of 4 weeks. Symptoms of discomfort, swelling, fatigue, aching and the perception of tight legs improved significantly when the flight attendants were wearing the compression hosiery during the waking hours (Weiss & Duffy, 1999).

Hsiu-Fang and Feng-Ping (2005), who reviewed several studies on compression socks and air travelers, reported when taking all reviewed studies into account, treatment groups had a smaller risk to develop DVTs in comparison with the control groups (Hsiu-Fang & Feng-Ping, 2005). The beneficial effects of CG were also seen in women whose work setting required standing for long periods of time (Kraemer et al., 2000). For example, Kraemer et al. (2000) tested the effects of CG in women who stood for 8 hours on a hard floor. The CG led to a significant reduction in edema in the legs and ankles and a significant reduction in lower body discomfort.

These findings are echoed by the CEP, the leading manufacturer of compression socks. That is, CEP claims compression aids the heart by facilitating venous return. According to CEP, compression also supports arterial blood flow, which would bring

more nutrients and oxygen to the legs, and, therefore, reduce feelings of discomfort. Perhaps the changes in vascular dynamics afforded by compression can enhance performance, reduce muscle damage and perceived soreness (Armstrong, 1984) as well as hasten recovery.

Compression Socks in Athletic Settings

Duffield, Cannon, & King (2010) found that wearing CS enhanced performance in various types of exercise. For example, Higgins, Naughton, & Burgess (2006) tested the effects of compression socks in netball players, during a simulation of a game-specific circuit, which was especially created for netball players. They tested the difference between netball specific garments, compression garments, and no garments at all. They came to the conclusion that greater distances were covered at faster velocities, when wearing compression garments. They also saw a significant improvement in repeated performance at high speeds in netball players (Higgins, et al., 2006).

Doan et al. (2003) tested compression shorts in track athletes. They found countermovement vertical jump heights increased while flexion and extension torque was improved. The authors also report a 27% lower impact in track athletes, when sprinting and jumping, due to the support and stabilization of the hamstring with the CG (Doan et al., 2003). Similarly, Kemmler et al. (2009) tested compression socks with a constant-compression profile on running performance in 21 moderately trained athletes. He found that time under load, which was used to determine maximal running performance, as well as total work at the aerobic threshold and the anaerobic threshold, was increased significantly when wearing compression socks (Kemmler et al., 2009).

Scanlan et al. (2008) studied cyclists to determine if a lower body CG influenced performance during a one-hour cycling time trial. Results revealed an improvement in power output at the anaerobic threshold, as well as an improvement in muscle oxygenation economy. No differences were found for physiological measures like VO_{2max} between groups (Scanlan et al., 2008). The authors suggested the compression socks facilitated blood flow and improved lactate clearance, both of which might assist performance over an extended period of time.

Compression Socks Improve Symptoms of Muscle Damage (Delayed Onset of Muscle Soreness)

Various studies were done to investigate the effects of compression socks on symptoms of muscle damage. Duffield et al. (2010) conducted a study with rugby players who performed two bouts of intermittent sprints on two consecutive days with compression socks worn between bouts in the experimental group and no socks in the control group. The authors evaluated performance and measured markers of muscle damage and soreness. Results indicated no significant between group differences for performance and muscle damage. A significant difference was found, however, between groups on the rating of soreness with the experimental group reporting less soreness (Duffield et al., 2010). Similarly, Chatard et al. (2004) conducted a study with 63 year old sports men. Participants wore compression socks during an 80-minute recovery period between two bouts of exercise. Lower lactate concentrations were observed for the second bout of exercise, and the expected loss in power, during the second bout of exercise was reduced (Chatard et al., 2004).

Ali et al. looked at the effects of wearing graduated compression garments on physiological and perceptual variables during and after continuous running (10 k) exercise. However, the CG were only worn during and not after the running exercise. The CG reduced the onset of delayed muscle soreness significantly after exercise. They also observed a trend towards faster 10k times and a lower heart rate during the 10k for those wearing CG (Ali et al., 2007).

In summary, symptoms of muscle damage (muscle soreness) are increased after exercise. Yet, as far as compression garments, no studies to date have reported that CG actually reduces these symptoms if compression socks were worn only post exercise and not during exercise. Thus, this study will approach the question of whether compression worn for 6 hours after exercise influences post-exercise muscle soreness.

Chapter 3: Methods

Sample and Population

Twelve recreationally active and apparently healthy male and female students between the ages of 18-35 years were recruited from the local community and Florida Atlantic University. Recreationally active was defined as those individuals who currently participated in club sports or fitness activities for 30-60 minutes 2-5 times a week. To be included, participants were free of musculo-skeletal injury, had no coronary heart disease (CHD) risk factors. This study was approved by the Institutional Review Board for Human Subjects Experimentation at Florida Atlantic University prior to data collection. Participants were informed of the study protocol, including risks, prior to providing written informed consent. For their participation, subjects received a pair of the CEP compression stockings with a value of approximately $50.

Compression Garments

Below knee compression socks (CEP, GmbH & Co., Germany), composed of 85% polyamide and 15% elasthan, were used in the experimental condition of this study. The compression profile of CEP socks exerted a compression of 24mmHg at the ankle and gradually reduced the compression to 80% of the original compression, as the stocking ascended to the calf. Per the manufacturer, the compression at the calf was between 18-20mmHG and was relatively constant over the whole calf area.

Familiarization and General Testing Procedures

The testing protocol included one introduction session and two soreness-inducing sessions. All three sessions were approximately one week apart to ensure 100% recovery. After 24-hours post exercise, subjects were allowed to resume their normal physical activity.

All subjects went through an introduction or familiarization session including reading and signing informed consent, completing a health history questionnaire, and having their height, weight, and calf circumference measured. Specifically height was measured with a metric tape measure affixed to wall. Weight was assessed with a digital platform scale Toledo, model 2095 (+/- 50g accuracy). The calf was measured on the right leg at the greatest circumference with the distance below the lateral condyle recorded and used as an anatomical site for subsequent measurements. During the introduction session, the investigator reviewed the soreness- inducing protocol with each participant, and actually had the participant perform one repetition of the soreness-inducing protocol at the Exercise Science and Health Promotion laboratory of FAU.

The soreness-inducing protocol included a 20m sprint, decelerating the last 10m, followed by 10 deep double-leg bounds for total distance from a stationary squat position. The deceleration, having an eccentric component, was thought to promote muscle damage/soreness. The deep double-leg bound started from a standing position, followed by a squat (depth = right angle at the knee) and forward bound as far as possible (arms were used in a swinging motion to assist with bounding). The one repetition protocol gave the subject an opportunity to experience the actual movement and challenging nature of the exercise protocol. Time to complete one repetition (i.e. sprint plus 10

bounds with length of total bounds) was recorded. Data collected during the one repetition was used as a reference point or benchmark for the subsequent two testing sessions. Subjects were instructed to avoid consuming any alcohol and to avoid extensive and strenuous exercise 24 hours prior to all testing sessions and not to alter their dietary habits throughout the experiment.

Exercise Testing Session 1and 2 in the Exercise Science Lab of FAU:

This study used a randomized crossover design. Participants were initially randomly assigned to either a post-exercise compression sock (worn for a total of 6 hours) or no post-exercise compression sock condition. After completion of the first testing session, participants subsequently switched groups, so that all subjects participated in both conditions. The soreness-inducing session was a point to point trial that included a 20-m sprint, decelerating the last 10-m followed immediately by 10 deep double-leg bounds for distance performed from a stationary squat position. Upon completion of a repetition (i.e. after the 10^{th} bound), the participant ran back to the starting line of the 20m sprint and rested until the minute had elapsed. The subject had no more than one minute to complete the sprint and 10 bounds. The participant completed a total of 10 repetitions of the sprint-bound cycle. After each cycle, Heart Rate (HR) was measured with a Polar Heart rate monitor. Each participant rated their perceived exertion (RPE) according to the Borg Scale (6 to 20 where 6 is equivalent to no exertion at all, and 20 is equivalent to maximal exertion). The time to complete the sprint bounding protocol (10 repetitions), including bounding length was recorded for both trials to ensure reliability. For the CS condition, compression socks were put on immediately post-exercise and worn continuously for 6 hours. Soreness as assessed by asking the

participant to rate their muscle soreness based on a 0-6 point scale (6 = very sore) at time point (i.e. prior, immediate post, 6 and 24 hours post exercise).

Data Analysis

A two-way repeated ANOVA (CS condition by time) was performed to evaluate the effects of compression socks on perceived soreness (Vickers scale 0-6) at baseline (time zero), immediate post-exercise, 6 and 24 hours post-exercise. A p value <0.05 was accepted as statistically significant. The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for Microsoft Windows (Version 17.0.1, 2008; SPSS, Inc., Chicago, IL).

Chapter 4: Results:

This study was carried out to evaluate the effect of post-exercise compression on perceived soreness (PS). To that end, a total of 18 subjects were recruited for the study, two of whom dropped out (i.e. one failed to return after the introduction session and a second subject did not continue with the second trial). Thus, eight male subjects and eight female subjects finished the entire study. One subject had an amputated leg. The subject characteristics are listed in the Table 1.

Table 1 Participants-Descriptive Characteristics

	Male (n = 8)	**Female (n = 8)**	**Total (n = 16)**
Age (yr)	25.5±3.5	22.9 ±2.6	24.2±3.3
Height (cm)	180.4±5.8	161.8±5.2	167.7 ± 9.5
Weight (kg)	78.2±6.6	57.6±4.9	67.9 ± 12
Calf Size (cm)	37.5±2.3	34.2±1.8	35.8 ± 2.4

Data presented as mean ± SD.

The performance measures reported in table 2 below include the subjects' HR responses and perception of effort during the soreness inducing protocol (i.e., bounding squats for distance and sprinting cycle). The ANOVA revealed no between conditions difference in any measure of performance.

Table 2 Measures of Performance

	No Compression	Compression	Significance
HR (bpm)	176.3±9.7	176.3±8.7	.988
RPE (6-20)	14.2±1.4	14.2±1.9	.966
BL (m)	16.1±3.7	16.2±3.3	.985
Time (sec)	30.2±4.3	29.4±4.0	.582

Data are presented as mean ± SD. HR=Heart rate, RPE=ratings of perceived exhaustion (Borg's 20 point scale), BL=bounding length (in meter), Time = average of 10 trials, significance = 0.05

Table 3 compares the PS values of subjects between the two conditions. The PS numbers tended to be lower after 6 and 24 hours post exercise in the compression group, yet failed to reach significance at any time point. There was also a significant trend in increasing soreness values over time in both conditions.

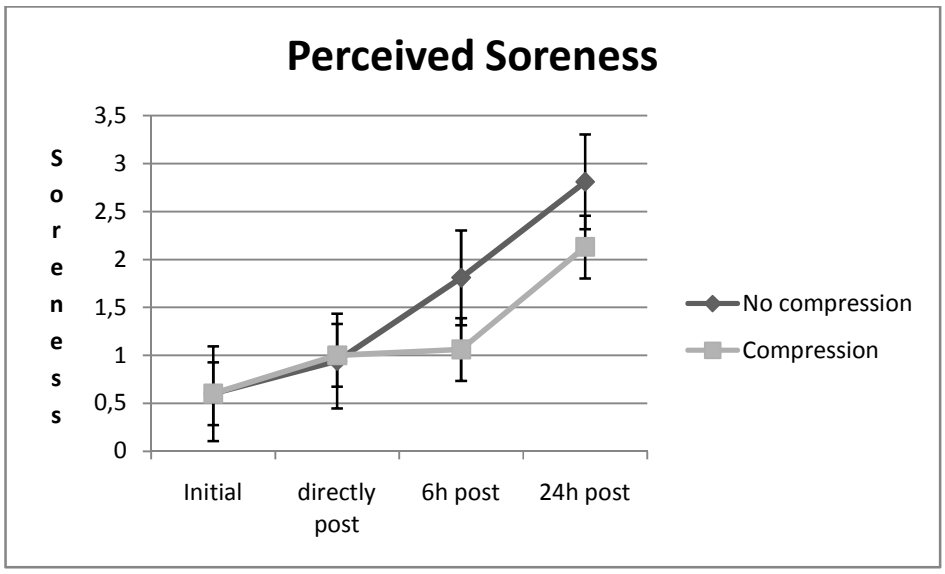
Table 3 Perceived Soreness Over Time

Condition	Initial	Immediate Post	6h post	24 h post
No Compression	0.6±.25	0.94±1.44	1.81±1.55	2.81±2.10
Compression	0.6±.25	1.00±1.27	1.06±1.81	2.13±1.41
Significance	1	0.897	0.136	0.286

Data are presented as mean ± SD. Soreness levels depicted as Vickers point scale from 0 to 6. Significance <0.05

As illustrated in Figure 1, a non significant trend exists for compression to reduce PS at 6 and 24 hours post-exercise

Figure 1: Perceived Soreness between conditions (0-6)



Chapter 5: Discussion

The purpose of this study was to determine whether wearing below knee compression socks following a soreness inducing exercise protocol influenced perceived muscle soreness (PS). The soreness inducing exercise protocol included a ten-minute sprint and squat jump or bounding workout. As performance markers, heart rate (HR), rate of perceived exertion (RPE), bounding length (BL) and time needed to complete each of 10 sprint-jump cycles (TSJ) were measured. Given that each subject completed the soreness inducing protocol twice, performance measures were compared across trials to assess reliability (see results Table 2). Perceived soreness was assessed both pre- and post- workout with a scale ranging from 0 to 6. The number 0 indicated a complete absence of PS. The number 7 indicated that the subject had severe pain which limited his or her ability to move.

Consistency Across Trials

No difference in any measure of performance existed between trials during the soreness inducing protocol. Thus, the effort put forth by the subjects was similar across both soreness inducing trials. Specifically, in both trials, HR, RPE and TSJ increased from the first cycle to the tenth cycle, whereas BL decreased. This finding was expected given that the soreness inducing protocol called for 10 repetitions of the sprint bounding.

Perceived Soreness (PS)

While PS did not differ between conditions prior to exercise or directly post exercise, PS was lower in WC as compared to the NC at 6 hours and 24 hours post-exercise, but this difference did not reach significance. Speculatively, observed differences, although not significant, in PS at 6 hours and 24 hours post exercise may have been due to the effects of below knee compression.

Unlike the present study, other investigators have reported significant differences in PS between compression and no compression conditions (Duffield et al., 2008; Higgins et al., 2006; Jakeman, Byrne, & Eston, 2010). For example, Jakeman et al. (2010) found significant reduced muscle soreness with lower limb compression following plyometric exercise compared to passive recovery. Similarly, Higgins et al. (2006) showed that wearing compression socks influenced PS after a high intensity sprint and plyometric exercise (similar to the present study). As with the current study, Higgins' subjects were wearing the compression garments for a total of 24 hours following exercise. Finally, the same 24 hour model was used by Duffield et al. (2008) who found that PS levels were significantly lower 24 hours after a high intensity circuit when subjects wore compression socks post-exercise. As such, the results of this study are somewhat puzzling given the findings of other investigators.

The subjects in this study were not athletes or avid sports participants. As such, and contrary to athletic populations who are notorious for withstanding pain and soreness it is possible the subjects in this study simply were unable to push hard enough to inflict substantial damage/soreness.

Again, the results of this study were contrary to other investigations, (Duffield et al., 2008; Higgins et al., 2006; Jakeman, Byrne, & Eston, 2010) in which significant soreness was detected at 24 hours post exercise. There would appear to be several possible explanations for this apparent contradiction. First, the soreness inducing protocol used presently might not have caused sufficient soreness for the subjects. Only one subject reported a PS of 5 at 24 hours. Whereas the average level of PS was much lower (2.47±1.80 at 24 hours and 1.44 ±1.43 at 6 hours). Per the Vickers' (2001) scale, a value of 1 indicates that the subject only felt light pain when touched and a value of 3 indicates that subject had light pain when walking up and down stairs. Thus, it appears that the soreness inducing protocol was unable to produce particularly high PS values with no apparent weakness or limitations to move. Moreover, some of the subjects felt no soreness (PS=0) at any time after the workout across both conditions. Perhaps, 24 hours might not have been enough time to reveal significance between condition differences. For example, Flores, Brown, Pinto, Carregaro, & Bottaro, (2011), who looked at the time course response of delayed onset muscle soreness (DOMS) after a resistance based workout, reported that DOMS peaked as late as 48 hours post exercise.

Conclusion

This study failed to prove the hypothesis that compression socks reduce participants rating of perceived soreness significantly even though a trend towards lower ratings was observed.

Future Directions

In light of the findings of this study, future investigations should explore more demanding soreness-inducing protocols and perhaps, consider evaluating PS as far out as 48 hours as well as evaluating the effects of compression on a more athletic population. Finally, considering that the soreness inducing protocol did not elicit higher levels of PS, further study is needed in order to determine whether compression socks, applied post exercise, can reduce PS.

Appendixes

Appendix A: IRB Approval

FAU
FLORIDA ATLANTIC UNIVERSITY

Institutional Review Board

Tel: 561.297.0777 Fax: 561.297.2319
www.fau.edu/research/rca

Nancy Aaron Jones, Ph.D., Chair

Administrative Staff
Elisa Gaucher
Angela Clear
Tina Horton

DATE:	September 28, 2010
TO:	Michael Whitehurst, Ed. D
FROM:	Florida Atlantic University IRB
PROTOCOL #:	H10-133
PROTOCOL TITLE:	[186891-2] Effect of Compression Stockings on Cycling Performance, Post Exercise Muscle Damage/Soreness in Moderately Trained Females.
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	September 28, 2010
EXPIRATION DATE:	September 27, 2011
REVIEW TYPE:	Full Board
REVIEW CATEGORY:	Full Board

Thank you for your submission of New Project materials for this research study. This study was originally reviewed by Full Board, but their concerns and your subsequent response was deferred to expeditors for final review.

The Florida Atlantic University IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

- The IRB understands that the use of compression stockings in this study is for the sole purpose of enhancing peformance during exercise and not to diagnose, mitigate or treat a disease.
- This study has been approved for a maximum of 30 subjects.
- It is important that you use the approved, stamped consent documents or procedures included with this letter.
- Please note that any revision to previously approved materials or procedures, including modification to approved enrollment numbers, must be approved by this office prior to initiation. Please use the appropriate amendment forms for this procedure.
- All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed, if applicable.
- Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.
- Please note that all research records must be retained for a minimum of three years.

- **This approval is valid for one year.** A Continuing Review form will be required prior to the expiration date if this project will continue beyond one year.

If you have any questions or comments about this correspondence, please contact Elisa Gaucher at:

Institutional Review Board
Research Integrity/Division of Research
Florida Atlantic University
ADM Bldg. 10, Suite 239
Boca Raton, FL 33431
Phone: 561-297-0777

* Please include your protocol number and title in all correspondence with this office.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within our records.

Appendix B: Recruitment Flyer

Research Study

Florida Atlantic University

Exercise Science and Health Promotion Lab

Field House 11A

Recruiting starts: February, 2011

Effects of Compression Stockings on Muscle Damage Post Exercise

What will you do?

• Two - 10 minute exercise sessions of running and jumping designed to make you sore. After one of the sessions you will wear compression socks for six hours to see whether the compression reduces the soreness.

Benefits for participants*:

- You will receive one pair of compression socks ($50 Value) FREE

*Participation is absolutely voluntary

Qualifying Criteria:

- Recreationally active*male or female
- 18 – 35 years old
- Good accessible veins (we will draw blood on several occasions)

- * Recreationally active refers to those individuals who participate in any kind of activity 2-5 times a week for 30-60 minutes

IF INTERESTED, CALL Friederike@ 561-306-7857

Appendix C: Health History Questionnaire

FAU
FLORIDA ATLANTIC UNIVERSITY

ESHP Department

HEALTH HISTORY

All information you provide is personal and confidential. The information will enable us to better understand your current health status and potential risks associated with your participation in this research study.

PARTICIPANT GENERAL INFORMATION

Date_____
Name_____
Address_____
City State Zip_____
Gender_____ Birthdate _____
Phone (_____) _____
Email _____

Physician's Name _____
Physician phone number (_____) _____
Physician fax number (_____) _____
Emergency Contact
Name _____
Relationship_____
Home phone _____

HEALTH HISTORY

General

Height _____ ft. Weight_____ lbs.

Do you currently exercise? YES ☐ NO ☐

If yes, how long have you been exercising regularly?

_____

_____

What exercises do you do and how often?

_____

_____

Medical Diagnosis

Have you ever had any of the followings?

Diabetes	YES ☐	NO ☐
High blood pressure	YES ☐	NO ☐
Stroke	YES ☐	NO ☐
Cancer	YES ☐	NO ☐
Heart disease	YES ☐	NO ☐
Kidney disease	YES ☐	NO ☐
Heart Attack	YES ☐	NO ☐
Angina	YES ☐	NO ☐

Asthma	YES ☐	NO ☐
Anemia	YES ☐	NO ☐
Osteoporosis	YES ☐	NO ☐
Cardiovascular Surgery	YES ☐	NO
Currently Pregnant	YES ☐	NO ☐
Emphysema	YES ☐	NO ☐
Allergies	YES ☐	NO ☐
Emboli - (Blood Clot)	YES ☐	NO ☐
Coronary Artery Disease	YES ☐	NO ☐
Pulmonary Disease	YES ☐	NO ☐
Heart Valve Problems	YES ☐	NO ☐
Rheumatic Fever	YES ☐	NO ☐
Phlebitis (inflammation of vein)	YES ☐	NO ☐
Difficulty Breathing	YES ☐	NO ☐
Poor Circulation	YES ☐	NO ☐
Frequent Colds	YES ☐	NO ☐
Persistent Cough	YES ☐	NO ☐
Ringing in Ears	YES ☐	NO ☐
Rapid/irregular heart beat	YES ☐	NO ☐
Swollen joints	YES ☐	NO ☐
Pain, weakness, numbness in:	YES ☐	NO ☐

☐ Arms ☐ Hands
☐ Legs ☐ Feet
☐ Neck ☐ Shoulders
☐ Head ☐ Hips

Florida Atlantic University Form HH01

HEALTH HISTORY…CONTINUED

List medications or food supplements you are taking:

R_X Name _____
Reason _____ Dosage _____

R_X Name _____
Reason _____ Dosage _____

R_X Name _____
Reason _____ Dosage _____

R_X Name _____
Reason _____ Dosage _____

List any allergies:

_____
_____
_____
_____

List serious illnesses, accidents, surgeries or special condition not listed on page 1:

_____
_____
_____
_____

Major Risk Factors

1. Has your father experience a heart attack before the age of 55 **YES** □ **NO** □
2. Has your mother or sister experience a heart attack before the age of 65 **YES** □ **NO** □
3. Has your doctor ever told you that you might have high blood pressure **YES** □ **NO** □
4. Do you have cholesterol above 200 ml/dl? **YES** □ **NO** □
   Total Cholesterol _____ HDL _____
   Date tested _____ Unknown _____
5. Do you have impaired fasting glucose (diabetes or pre-diabetes) **YES** □ **NO** □
   If yes, do you take insulin? **YES** □ **NO** □
   What year were you diagnosed? _____
6. Are you physically inactive? **YES** □ **NO** □
   (less than 30 minutes of physical activity on at least 3 days per week)
7. Do you currently smoke or have you quit smoking in the last 6 months? **YES** □ **NO** □
   a). I smoke (#) _____ cigarettes per day/week (circle one) for _____ years
   b). I smoked (#) _____ cigarettes per day/week (circle one) _____ years ago

SIGNATURE

I understand this Health History has been provided to me for the purpose of helping me better understand any potential risk associated with my participation in this research study. My signature signifies that all the above is true, to the best of my knowledge. Any information left unanswered was done intentionally. If any of the above information changes, I agree to inform the principle investigator.

Participants Signature _____ Printed Name _____ Date _____

Investigator Signature _____ Printed Name _____ Date _____

Note: All major risk Factors, Signs & Symptoms classification are taken directly from Whaley, Mitchell H ed. ACSM's Guidelines for Exercise Testing and Prescription. Philadelphia, PA: Lippincott Williams & Wilkins, 2006

OFFICE USE ONLY

Florida Atlantic University Form HH01

Appendix D: Informed Consent

RESEARCH SUBJECT INFORMATION AND CONSENT FORM

TITLE: **Effect of Compression Stockings worn post exercise on Muscle Damage**

PROTOCOL NO.: **193670**

SPONSOR: **N/A**

INVESTIGATOR: **Michael Whitehurst, Korey Kilsdonk, Friederike Feil, Robert Zoeller, Sue Graves**

SITE(S): **Florida Atlantic University, Boca Raton Campus**

STUDY-RELATED PHONE NUMBER(S): **For PI: 561.297.2317 (office), 561.302.2674 (cell),**

PLEASE READ: This consent form may contain words that you do not understand. Please ask the study doctor or the principle investigator (Dr. Whitehurst) or the study staff to explain any words or information that you do not clearly understand. You may take home an unsigned copy of this consent form to think about or discuss with family or friends before making your decision.

SUMMARY

As a research participant, please know that we are in no way providing ANY form of health assessment or health care. Rather, we are attempting to determine if wearing a compression stocking after a soreness inducing exercise protocol can reduce muscle damage post exercise. As a research participant, it is your right to withdraw from the study at any time for any reason or simply decide not to participate in a particular aspect of the study. It is your responsibility (as well as ours) to be vigilant with regard to how you are responding during the exercise, and even how you might feel when we draw blood from your arm. That is, if for any reason you do not like the way you feel or how we are administering any aspect of the study, please inform us immediately. Finally, as a research participant in this study, please know we are going to draw blood from your arm (s) 4 times during the course of a 24-hour period ON two occasions separated by approximately seven days.

PURPOSE OF THE STUDY

The purpose of this study is to determine if wearing a below knee compression stocking after a soreness inducing exercise protocol reduces muscle damage/soreness. To answer this question, we will compare your physical responses post exercise with and without the compression stockings worn post exercise. Additionally, and perhaps most importantly, we will be measuring a protein in your blood that, when elevated, reflects muscle damage. Ultimately, we may get a good idea, if wearing a compression stocking, after a hard workout, can reduce muscle damage and feeling of soreness.

PROCEDURES

Assuming you have met the criteria listed below:

1 _____ initials

FAU Institutional Review Board

Approved on:	3/2/2011
Expires on:	3/2/2012

- Participate in any type of exercise training not more than 2-3 times a week for 30-60 minutes (recreationally active).
- Between the ages of 18 – 35
- Present veins in your arms that are relatively easy to obtain blood from

You will report to the Exercise Science Laboratory directly behind the FAU Field House to complete TWO complete soreness inducing exercise protocols (each about 7 days apart) and ONE modified protocol to become familiarized with the testing procedure. TWO additional visits on the "real" testing days (complete protocol is administered) for blood draws are required. In all you will make 5 visits to the lab. During the first day of testing, you will read and sign a consent form, health history and review with the investigator (s) the purpose of the research and become familiar with the testing procedure. Following paperwork and familiarization, an investigator will measure your calf circumference on the dominant leg (to determine the size of compression stocking you will wear on the testing day for the experiment). Your height and weight will also be measured by the investigator. The test is administered as follows:

- A bicycle ergometer will be adjusted to your height. You will do an easy warm up of five minutes pedaling against 75 watts at an rpm between 60 and 80.
  After the warm up, you will have to participate in a soreness inducing protocol.

- This protocol includes 20-m sprint, where you have to decelerate the last 10-m. Immediately after the sprint, you will do 10 deep, double leg bounds for distance performed from a stationary squat position. Then you will have to run back to the start line and rest until one minute has elapsed. **Note:** You DO NOT HAVE MORE THAN ONE MINUTE to complete the sprint and the 10 bounds. This sprint-bound cycle will be repeated for a total of 10 times. Performance will be assessed by measuring the time to complete each repetition (20m sprint plus 10 bounds), and the distance covered during each bound.
- On one of the tests (this will be randomly assigned in a cross-over fashion), you will put on a below knee compression stocking (CS) immediately post exercise for the next 6 hours. You will be fitted with a CS according to your calf circumference measured on the first day of testing. Know the CS is of medical grade, and is graduated with the compression greatest at the ankle and the least at the calf.
  On the other testing day, you will do the same soreness inducing protocol but without wearing the CS post exercise. NOTE: Your performance should not differ between conditions.
- Additionally, after each repetition of the sprint-bound cycle, you will be asked to select a number between 6 to 20 (20 = extremely hard - all out) to reflect your total body feeling and the physical demands after each sprint-bound cycle.
- In the familiarization session, you will be only asked to do the sprint bound cycle once, so we can get some approximate measurements of how long it will take you to complete one cycle and the distance of your jumps. This session provides you the opportunity to become more comfortable with the protocol.

_____ initials

- The familiarization session and the subsequent two tests will be administered approximately one week apart, to ensure 100% recovery between the tests.
- Furthermore, you will be contacted by the researcher one day after the soreness inducing protocol to subjectively assess your level of soreness and overall impression of the exercise protocol. Any unusual symptoms should be reported to the investigator.

PLEASE UNDERSTAND THE SORENESS INDUCING PROTOCOL IS SUPPOSED TO CREATE MUSCLE DAMAGE AND MAKE YOU SORE! GIVEN THAT YOU DO NOT HABITUALLY EXERCISE, THIS FEELING OF SORENESS MIGHT NOT BE VERY COMFORTABLE, SINCE IT IS SOMETHING YOU ARE NOT USED TO. The CS and non-CS exercise tests will take approximately 30 minutes each.

For each of the CS/no CS test days, an investigator experienced in phlebotomy (collecting venous blood samples) will draw 10 ml (1 ml is 1000th of a liter or quart or in practical terms about 2 teaspoons) of blood from the median cubital vein (inside of arm at the elbow) approximately 30 minutes before testing, immediately post - test, six hours post, and 24 hours post (we will alternate arms). The six hours post and 24 hours post-exercise blood draws require you return to the lab for a total of 15 minutes each. Since you will not be sequestered during the post-exercise period, it is IMPERATIVE you DO NOT participate in exercise of any kind or exert yourself during the six hours post exercise or during the following day prior to the 24 hour post-exercise blood draw. Additionally, you will be asked to rate your level of soreness based on a 1-7 point scale (7 = very sore) at the time of each blood draw. Finally, please realize that we have created a relatively private area for blood draws wherein we emphasize safety and cleanliness at all times.

The container into which blood will be drawn from your arm will be coded numerically, then spun in a refrigerated centrifuge (spinning apparatus) to separate the large proteins (e.g. RBCs, platelets) from the serum (liquid portion of blood). Your samples will be stored in a -80 degree F freezer for analysis, not to exceed six months. Please understand we are interested in testing several milliliters of your blood serum for a marker of muscle damage. The marker of muscle damage is a chemical in your blood named Skeletal Troponin. It is the chemical in the blood that is central to this study. That is, will wearing CS influence muscle damage/soreness as expressed by an increased concentration of this chemical in the blood? Finally, we may also test your blood serum for inflammatory markers (e.g., C-reactive protein). However, we WILL NOT test your whole blood or blood serum for anything besides that which is specifically stated in this consent. Moreover, your blood samples, without any form of identification, will be disposed of in hazardous waste containers immediately following the analysis, not to exceed six month.

RISKS AND DISCOMFORTS

The risks associated with this study include:

- The obvious risk during venipuncture (obtaining intravenous access) is the development of infection at the site (i.e., the medial cubital vein - at the inside of elbow) of placement of the needle used to withdraw the blood. There is a slight risk any time the skin is broken. Other risks include excessive bleeding, fainting or feeling light headed. In rare occasions, a hematoma can form under the skin (blood accumulating under the skin), or

_____ initials

there might be the need to perform multiple punctures to locate the veins. A hematoma and multiple punctures usually heal with time. The person drawing the blood is well-trained and performs the technique using standard disinfecting procedures. Precautions taken are rather standard - disinfection of the site of needle insertion and use of sterile technique throughout the procedures. The phlebotomist (person who will take your blood) will ascertain if you are taking medication/vitamins or have any conditions that may increase the likelihood of bleeding. You should not give blood or have it drawn, if you are anemic.

- Since you are not regularly trained, you WILL experience leg discomfort after you have performed the soreness inducing protocol (that is the point of the study) with the soreness resolving itself within 24-72 hours. *Please understand the soreness is caused by muscle damage which can be characterized as muscle cells that rupture which allows the cytosol (cell fluid and proteins) to leak out causing localized edema or swelling which in turn puts pressure on sensory nerve endings (this is what we recognize as pain). Again, the pain or soreness should pass in 24-72 hours.*
- Extremely unlikely, but still, you could experience an unexpected heart rate and/or blood pressure response and/or heart arrhythmia during the exercise protocol. Should an unexpected event occur during testing, the investigator (s) will initiate standard laboratory procedures to immediately contact EMS by calling 911.

NEW INFORMATION

You will be told about anything new that might change your decision to be in this study. You may be asked to sign a new consent form, if this occurs.

BENEFITS

As a result of your participation in this study you can expect:

- To receive one pair of the CEP compression socks (value of $50) after you have completed the study (i.e., all sessions).
- Finally, your involvement in this study may provide useful data in the quest for a better understanding of the role of compression garments in exercise performance and post-exercise muscle damage.

COSTS

There are NO costs to you as a research participant.

_____ initials

AUTHORIZATION TO USE AND DISCLOSE INFORMATION FOR RESEARCH PURPOSES

All information we obtain about you or as a direct result of your participation will:

- Be stored in the investigators office under lock and key and/or in a password protected computer with ID used rather than your name.
- Mean your name or any information we may gather will not be released to anyone (except immediate research staff) without your written permission, unless required by law.
- Pertain to all data associated to your involvement in this study will be destroyed after five years.
- Relate to the results of this study, not identifiable to you, may be shared in a public forum, such as a professional meeting and published in a scientific journal.
- Indicate you may withdraw or take away your permission (by simply telling us to do so) to use any or all data pertaining to participation in this study.

COMPENSATION FOR INJURY

• PLEASE KNOW that FAU is not able to offer financial compensation nor to absorb the costs of medical treatment should you be injured as a result of participating in this research.

VOLUNTARY PARTICIPATION AND WITHDRAWAL

Your participation in this study is voluntary. You may decide not to participate or you may leave the study at any time. Your decision will not result in any penalty or loss of benefits to which you are entitled.

Your participation in this study may be stopped at any time by the principal investigator (Dr. Whitehurst):

- if it is in your best interest;
- if you miss a testing session.

QUESTIONS

Contact Dr. Michael Whitehurst at (561) 297.2713 (office), (561) 302.2674 (cell) for any of the following reasons:

- if you have any questions about this study or your part in it,
- if you feel you have had a research-related injury,
- if you have questions, concerns or complaints about the research

If you have questions about your rights as a research subject or if you have questions, concerns or complaints about the research, you may contact:

Florida Atlantic University, Division of Research at (561) 297-0777.

Do not sign this consent form unless you have had a chance to ask questions and have received satisfactory answers.

_____ initials

CONSENT
I have read this consent form (or it has been read to me). All my questions about the study and my part in it have been answered. I freely consent to be in this research study. I have been provided a copy of this consent form for my records.

By signing this consent form, I have not given up any of my legal rights.

_____
Subject Name (printed)

CONSENT SIGNATURE:

_____ _____
Signature of Subject (18 years and older) Date

_____ _____
Signature of Person Conducting Informed Consent Discussion Date

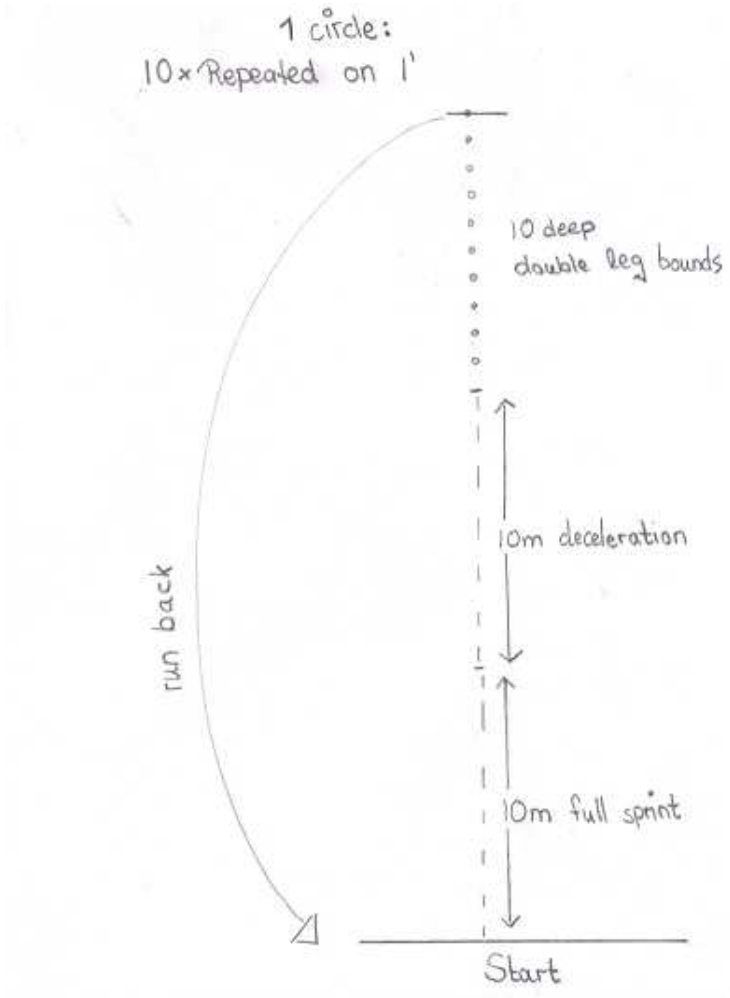
3/2011

FAU Institutional Review Board

Approved on:	3/3/2011
Expires on:	3/2/2012

_____ initials

Appendix E: Soreness Inducing Protocol



Appendix F:Vicker's Soreness Scale

Please tick the sentence below that best describes your level of muscle soreness over the past 12 hours.

[ ]0	A complete absence of soreness
[ ]1	A light pain felt only when touched / a vague ache
[ ]2	A moderate pain felt only when touched / a slight persistent pain
[ ]3	A light pain when walking up or down stairs
[ ]4	A light pain when walking on a flat surface / painful
[ ]5	A moderate pain, stiffness or weakness when walking / very painful
[ ]6	A severe pain that limits my ability to move

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