

SUNY College Cortland

Digital Commons @ Cortland

Master's Theses

5-2015

Effects of thigh compression wraps on sprint performance in a physically active population 2015

Kevin Ostempowski

Follow this and additional works at: <https://digitalcommons.cortland.edu/theses>



Part of the [Exercise Physiology Commons](#), [Exercise Science Commons](#), and the [Sports Studies Commons](#)

Recommended Citation

Ostempowski, Kevin, "Effects of thigh compression wraps on sprint performance in a physically active population 2015" (2015). *Master's Theses*. 129.
<https://digitalcommons.cortland.edu/theses/129>

This Open Access Thesis is brought to you for free and open access by Digital Commons @ Cortland. It has been accepted for inclusion in Master's Theses by an authorized administrator of Digital Commons @ Cortland. For more information, please contact DigitalCommonsSubmissions@cortland.edu.

Effects of Thigh Compression Wraps on Sprint Performance
in a Physically Active Population

by

Kevin Ostempowski

Submitted in Partial Fulfillment of the
Requirements for the Master of Science in Exercise Science Degree

Kinesiology Department

STATE UNIVERSITY OF NEW YORK COLLEGE AT CORTLAND

May 2015

Approved:

Date

Peter McGinnis, Ph.D.
Thesis Advisor

Date

Larissa True, Ph.D.
Thesis Committee Member

Date

Alyson Dearie, M.S.
Thesis Committee Member

Date

Erik Lind, Ph.D.
Thesis Committee Member

Date

Eileen Gravani, Ph.D.
Associate Dean, School of Professional Studies

ABSTRACT

Compression garments are widely used in sport to enhance performance. The purpose of this study was to examine the effect of thigh compression wraps on 60 m sprint performance. Twenty-six physically active college students, seven men and nineteen women, were participants in the study. The participants completed three 60 m sprints in each of two test sessions. The second test session occurred two to seven days after the first test session. The participant's thighs were compression wrapped in one test session, the treatment session, and not wrapped in the other test session, the control session. Whether or not the first test session was the treatment or control session was randomly determined. In each test session the participant completed a five-minute warm-up on a bicycle ergometer and then ran three 60 m sprints. After each sprint, the participant walked approximately 320 m before sprinting again five minutes after completing the previous sprint. The average 60 m sprint time was 0.100 s slower for the treatment sessions than for the control sessions, but this difference was not significant ($p=.057$). The women's average 60 m sprint time was 0.161 s slower for the treatment sessions than for the control sessions. This difference was significant ($p=.003$). The men's average 60 m sprint time was 0.067 s faster for the treatment sessions than for the control sessions, but this difference was not significant ($p=.601$). There was a significant change between all trials in each testing session, but there was only a significant change from the first trial to the second trial in the treatment session ($p=.047$). This may have been due to loosening effect of the compression wraps. The results indicate that the use of compression wraps has a negative effect on sprint performance in women. The results differ from all other studies examining the effects of compression garments on sprint

performance. The results of these other studies indicated that the use of compression garments in a small positive effect to no effect on sprint performance. Future studies should examine the effects of the use of compression wraps on performance in other activities.

TABLE OF CONTENTS

	PAGE
ABSTRACT.....	iii
LIST OF TABLES.....	vii
CHAPTER	
1. INTRODUCTION.....	1
Statement of the Problem.....	3
Purpose of the Study.....	3
Hypothesis.....	3
Delimitations.....	3
Limitations.....	4
Assumptions.....	4
Definition of Terms.....	4
Significance of Study.....	4
2. REVIEW OF LITERATURE.....	5
Compression.....	5
Compression Wraps.....	6
Psychological Effects.....	7
Lactate/Edema/Biomarkers.....	8
Thermic Effects.....	10
Mechanical Effects.....	11
Sixty Meter Sprint.....	13
Summary.....	13
3. METHODS.....	15
Participants.....	15
Procedures.....	16
Compression Wrap Application.....	18

60 m Time Measurement	21
Statistical Analysis.....	22
4. RESULTS	24
Comparison of 60 m Sprint Times Between Conditions	24
Comparison of 60 m Sprint Times Among Control Session Trials	25
Comparison of 60 m Sprint Times Among Treatment Session Trials.....	26
Comparison of 60 m Sprint Times Between Conditions for Women.....	28
Comparison of 60 m Sprint Times Between Conditions for Men	29
Average Change Score.....	29
Homogeneity of the Groups.....	30
Summary	31
5. DISCUSSION AND CONCLUSIONS	32
6. REFERENCES	37
7. APPENDICES	40
A. IRB Approval Letter	40
B. INFORMED CONSENT	42
C. PAR-Q	45
D. LOWER EXTREMITY INJURY QUESTIONNAIRE.....	46

LIST OF TABLES AND FIGURES

TABLES

1. Gender and Mean Height and Weight, of Participants
2. Mean 60 m Sprint Times by Test Session for Men, Women, and All Participants
3. Difference Between Control and Treatment 60 m Sprint Times
4. ANOVA of Control Trial 60 m Sprint Times
5. Pairwise Comparisons of Control Trial 60 m Sprint Times
6. ANOVA of Treatment Trial 60 m Sprint Times
7. Pairwise Comparisons of Treatment Trial 60 m Sprint Times
8. Difference Between Control and Treatment 60 m Sprint Times for Women
9. Difference Between Control and Treatment 60 m Sprint Times for Men
10. Average Change Score for Men and Women
11. Independent *t*-test Results between Average Change Scores of Men and Women
12. Levene's Test for Equality of Variances

FIGURES

1. Frontal view of thigh showing the compression wrap in place.
2. Mean 60 m sprint times for each trial and test session.

CHAPTER 1

INTRODUCTION:

The use of compression garments, such as tights, shorts, and sleeves, has increased in popularity among athletes. Advertisements for compression garments include claims that they support joints, prevent injury, or improve athletic performance. Athletic trainers generally use compression wraps and sleeves to control swelling due to ligamentous, muscular, or other soft tissue injuries. Several studies have examined the effects of compression garments on swelling, lactate accumulation, muscle warming, aerobic power, and speed (Borras et al., 2011; Bringard, Denis, Belluye, & Perrey, 2006; Doan et al., 2003; Houghton, Dawson, & Maloney, 2009; Born, Sperlich, & Holmberg, 2013).

A variety of compression garments have been studied relative to sprinting speed, including compression shorts, tights, and stockings. Born et al. (2013) found small positive effect sizes "...for improvements in single and repeated sprinting (10-60 m)...in participants wearing compression clothing" (p. 6). However, they also discovered that "the recovery of short-sprint ability (10–60 m) was negatively affected by the use of compression clothing" (Born et al., 2013, p. 12).

Compression garment use has been associated with reduced muscle oscillation and increased performance. Doan et al. (2003) determined that compression garment use decreased muscle oscillation. Reduction of muscle oscillation decreased the energy required to perform a movement, due to a decrease in the number of muscle fibers firing to perform a movement. Thus, it appears that by decreasing muscle oscillation, compression clothing also decreases the amount of structural damage to the muscle.

Averting such damage then contributes to a shorter recovery time and decreased muscle soreness experienced post-exercise (Duffield, Cannon, & King, 2010). Lactate, creatine kinase, albumin, and aspartate transaminase accumulation has been associated with fatigue and damage in muscle. Therefore, the decrease in these biomarkers reported by Duffield et al. (2010) would indicate decreased muscle fatigue and decreased muscle damage associated with the use of compression garments.

Compression garments have also been associated with increased muscle and skin surface temperature in comparison to no compression. An increase in temperature will lead to an improved function of the muscle. Warming of a muscle, due to compression, will decrease warm up time as well as keep the muscle warmer during competition. A warmer muscle is less susceptible to injury in start and stop activities as well as in a colder environment (Duffield et al., 2008).

The 20 m or 60 m sprint are the most commonly used tests of speed in studies of compression garments effects on sprint performance. Mackala (2007) noted that maximum velocity is reached between 40 and 60 m for non-elite sprinters. Participants for this study will not be elite sprinters. Sprint speed has not been found to be significantly affected by the use of compression garments (Doan et al., 2003).

Previous studies have examined the effects of compression garments on performance. This study will examine the effects of compression provided by thigh compression wraps instead of a compression garment such as compression shorts or compression sleeves. The compression wrap will compress the muscles of the thigh including the quadriceps (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius), adductors: (adductor magnus, adductor minimus, adductor longus),

abductors (iliotibial band and tensor fascia latae), and hamstrings (biceps femoris, semitendinosus, and semimembranosus). The compression wrap will start just above the knee and extend the length of the thigh.

Statement of the Problem:

The understanding of compressions efficacy in athletic performance has primarily been associated with the use of compression shorts or tights. The current study will broaden our understanding of the effects of compression on performance with the use of a compression wrap as the source of compression around the thigh.

Purpose of the Study:

The purpose of this study was to determine whether the use of thigh compression wraps decrease athletes' 60 m sprint times compared to their 60 m sprint times without thigh compression wraps.

Hypothesis:

There will be no difference in 60 m sprint times between compression wrap trials and control trials.

Delimitations:

1. Participants in this study were physically active college students.
2. The 60 m sprint testing took place indoors and in the same location during both testing sessions.
3. The subjects ran three trials per session without performance feedback.
4. Participants started from a standing position.
5. Only the researcher applied the compression wraps.
6. Two new wraps were used for each participant. One new wrap for each thigh.

7. The number of wraps around a participant's leg was not more than two wraps different than the number of wraps around the participant's other leg.
8. Individuals who had previously experienced a traumatic injury to a lower limb were excluded from the study. Traumatic injuries included, but were not limited to, any injury that required surgical intervention, and any strains of the lower extremity within the past year.
9. Individuals who had any current injury that would limit their 60 m sprint performance were also excluded from the study.

Limitations:

1. Tension in the compression wraps decreased with repeated use during the testing.
2. The actual tension of the compression wrap after its application was not measured.

Assumptions:

1. Participants ran at maximum speed for each sprint trial.
2. The tension was equal in the compression wraps on both legs.
3. Participants had the same activity level prior to each testing session.

Definition of Term:

Compression Wrap: 6" by 10 yard Latex-free polymer combined with woven yarns to provide balanced stretch, compression

Significance of the Study:

The significance of this study is it may determine compression wraps have the same effect on a 60 m sprint performance as a compression garment. This may lead to the use of compression wraps as alternative to the use compression garments in athletics.

CHAPTER 2

LITERATURE REVIEW

This chapter examines the current literature on the use of compression wraps and the use of compression garments and their effects. This review of literature is organized into seven topics: compression, compression wraps, psychological effects of compression, mechanical effects of compression, thermic effects of compression, the effect of compression on edema/lactate/biomarkers, and the 60 m sprint. These topics will be followed by a brief summary of all the research.

Compression

Compression is used in sport for a multitude of reasons such as: recovery, limitation of swelling, comfort, assistance with injured muscles, and increased performance. The different forms of compression include shorts, sleeves, full body suits, and wraps. Born et al. (2013) analyzed data from peer reviewed research articles regarding the effects of compression on the biomechanical, physiological, and psychological parameters of performance. They looked at the effect size in each study to determine their results. Born et al. (2013) determined that the use of compression clothing “has small effects on improving short duration sprints, vertical-jump height, and time to exhaustion, as well as time-trial performance” (p.16).

Compression is also used by a variety of populations ranging from athletes to working adults who wear stockings or sleeves around their joints for ease of motion. Jonker, de Boer, and Bezemer (2001) found that during the day there is a minor increase in swelling/edema in the legs. They discovered that the use of a lycra garment/sleeve helped reduce the amount of swelling in the legs compared to that of a control. The

garment or sleeve also decreased unpleasant feelings such as being tired after work (Jonker et al., 2001).

A problem associated with compression garment use in sport is sizing of the garments. Compression garments are not personally fitted for each individual. Although individuals may buy a size that fits, it may not exert a proper amount of compression needed to have an effect. Another problem associated with studies of compression garments is that the compression produced by the garment was not measured. The compression needed to maximize performance improvement has not been determined.

Compression Wraps

Compression wraps, were created to “primarily wrap injuries. When correctly placed, compression wraps impart support to strained tendons, ligaments, or muscles” (U.S. Patent No. 5,616,387, 1997 pg. 1). Compression wraps are used because they have two key properties that help support an injured area of the body: stretch and elasticity. These properties can be confused as the same thing, but have different meanings. The stretch property of the wrap allows it to stretch while a joint is moving or a muscle is contracting to move an area through a range of motion. The elasticity of the wrap allows it to return to the original form prior to stretch, continuing the support of the unmoving joint. (U.S. Patent No. 5,616, 387, 1997).

There are several draw backs of using compression wraps as seen in previous studies looking at amputees. One of the most important things discovered from these studies is that compression wraps loosen up as they are worn and must be taken off and reapplied in order to maintain proper compression. Compression wraps have also been found to have inconsistent pressure. They can have a different pressure from one wrap

around to the next. Compression wraps can also differ in the amount of compression from one use to the next. It has been noted in the same studies that there can be a tourniquet type of effect, cutting off blood flow to the lower extremity if wrapped around the upper leg (Rausch & Khalili, 1985). A potential positive use of the compression wrap is that it does not have to be modified based on the size of an athlete. Generally a 6" by 10 yard wrap is used to wrap an upper leg; whereas, a garment may be a size that does not produce enough compression to enhance performance.

Psychological Effects

Duffield and Portus (2007) and Duffield et al. (2010) found that there tends to be a possible placebo effect in relation to the perception of the effects of compression. They found a significant decrease “($P=0.01$; $d=1.1$),” (Duffield et al., 2010, p. 138) on muscle soreness 24 hours post exercise in the condition where the subjects wore a compression garment. Since no change in any metabolites were found in this particular study and muscle soreness was an immeasurable variable, the researchers believed that wearing the compression garment affected the perception of muscular soreness.

Bringard, Perrey, and Belluye (2006) looked at the effect of compression tights vs. elastic tights vs. a control. The main objectives of this study were to find if compression tights decreased the slow component of VO_2 , as well as energy cost. They also looked at how the compression garments compared to wearing normal shorts in perceived exertion, comfort, and thermal sensation. Their study elicited no significant differences between the compression garments and normal shorts. Therefore it may be inferred that they did not experience any effect on perception due to wearing compression as discussed by Duffield and Portus (2007) and Duffield et al. (2010).

Lactate/Edema/Biomarkers

Often compression stockings are given to older adults to help with edema in their feet and lower legs. The use of compression has also been studied to determine if its use is effective at decreasing lactate accumulation in fatigued muscles. Duffield, Cannon, and King in 2010 determined that the use of compression had no effect on lactate accumulation compared to a control.

Kraemer and colleagues (2001) asked women to perform an eccentric exercise routine for their biceps brachii muscles. Twenty subjects performed the test, 10 in the control group and 10 in the test group. The test group used a compression sleeve on the arm. The control group experienced a 2-3 cm increase in circumference of their upper arm compared to the group with the compression sleeve, which did not experience any increase in circumference. There was also a significant increase in elbow resting angle in the control group of 6-8% compared to the compression group. These results indicated that the compression sleeve reduced edema to the area and allowed for a greater resting elbow angle. There was no significant increase in lactate above baseline, contrary to what was found by Friden, Sfakianos, and Hargens in 1989 (as cited in Kraemer et al., 2001, p. 288).

Venous return and an increase in blood flow are the primary factors that decrease swelling (Bringard, Denis, Belluye, & Perrey, 2006). Bringard et al. looked at the difference between the effects of compression tights, elastic tights, and no compression on different hemodynamics. The group took their information from readings on the effects of stockings on hemodynamics in the lower leg. This led them to use a population that had great experience running due to the high focus on calf muscles in running.

Bringard et al. referenced Jonker et al. (2001) and his use of lycra support stockings to reason for the amount of pressure required to effect hemodynamics in calves. Jonker et al. had determined that the pressure ranging from about 10 to 30 mmHg led to the increase in venous return and blood flow. The compression tights used in the study had an average 23.2 mmHg of pressure while laying down and a 24.1 mmHg of pressure while standing. The pressure produced by the elastic tights was 5.6 mmHg while laying down and 5 mmHg while standing (Bringard et al., 2006, 551). They determined that the use of the compression tights was most statistically significant at decreasing deoxyhemoglobin and total sum of hemoglobin in the calves along with having a significant increase in tissue oxygenation index.

Another biomarker that has been studied in relation to muscle damage is albumin (Borras et al., 2011). Albumin has been associated with swelling due to an increase in the amount of albumin concentration leading to a higher oncotic pressure. Albumin has a high affinity to carry other particles with it while traveling to an area with decreased plasma volume. Plasma volume decreases with fatiguing muscles and therefore would cause more albumin to accumulate in the area (Borras et al., 2013).

Another lesser known biomarker has been studied by Duffield et al. (2010). They looked at the values of aspartate transaminase which is another enzyme found in the blood after muscle damage. Aspartate transaminase is generally not present until later in recovery, which is why they discovered no difference at the 2 hour post-test level. However, they did determine there was a small effect for a reduction in aspartate transaminase in the group with compression compared to the group with no compression. The findings by Duffield et al. (2010) determined that one of the mechanical benefits of

compression is decreased muscle damage and therefore decreased accumulation of recovery particles and enzymes.

Thermic Effects

Compression garments have been found to increase local skin/surface temperature, which could also increase in a muscular temperature. As found by both Bergh and Ekblom, (1979) and Sargaent (1987) this increase in muscular temperature has been related to an increase in dynamic strength, shifting the force-velocity curve, which caused a higher muscle velocity. This means that an increase in muscle temperature will increase the force a muscle can produce as well as its contraction velocity. Doan et al. (2003) discovered that the use of a compression garment “caused a significant increase ($P=0.003$ for men and women) in skin temperature compared with the loose-fitting gym shorts” (p. 607). Although they do not state the exact increase in skin temperature, they infer that it was raised about 1°C . As found by Astrand and Rodahl (1977) muscle function is most optimal at 38.5°C . Average body temperature is 37°C , so an increase of 1°C of local skin temperature leaves a difference of $.5^{\circ}\text{C}$ from optimal muscle temperature. Due to this effect, if an environment is too warm, the use of a compression garment may cause a negative effect by raising the muscle temperature above the optimal temperature for performance.

Houghton, Dawson, and Maloney (2009) studied field hockey players to determine if the use of compression garments raised temperatures higher than optimal during performance. They had participants wear upper and lower body compression garments or no compression garments. The participants’ core and skin temperature were both measured in this study. Core temperature was measured with an ingestible capsule

that sat in the gastrointestinal tract, and skin temperature was measured by wireless patches on the chest, forearm, thigh, and calf. There was a higher skin temperature with compression as compared to no compression, and that there was no significant difference in core temperatures between the two groups. Houghton et al. (2009) continued to mention that even though there was an increase in skin temperature that there was no negative effect on performance as “sprint times, HR, RPE and lactate concentrations” (pg. 307) remained similar between conditions.

Mechanical Effects

Compression garments, such as tights and shorts, have been found to limit the amount of muscle oscillation during an activity. Compression garments are used to compress and help support muscles, tendons, and ligaments underneath. During a fast movement muscles tend to over exaggerate and do more work than they need to. Compression has found to squeeze the muscle fibers and limit the amount of excess movement they perform.

Kraemer et al. (1996) examined compression shorts and found there was a larger maximum force generated by males, “wearing correctly fitted or undersized compression garments than when wearing regular gym shorts” (MacRae, Cotter, & Laing, p. 824). Higgins, Naughton, and Burgess (2009) also studied the difference in distance traveled in double leg bounds while wearing compression garments and discovered a small effect size of .53 with a 10% decrease, compared to a 14% decrease in those not wearing compression garments. These studies looking at jumping performance referenced the enhanced mechanical effects of hip proprioception and reduced muscle oscillation while landing (MacRae et al., 2011).

Doan et al. (2003) studied 20 Division I track athletes (10 male, 10 female) who specialized in sprinting and jumping events. There were multiple mechanical effects observed in both events. The use of compression garments created a significant reduction in hip range of motion at 55 meter mark in a 60 meter sprint compared to no compression. There was a (-5.08°) difference in hip range of motion, which led the researchers to believe that there may have been an increase in stride frequency (Doan et al., 2003). They also noted that even though it was not significant that there was a trend towards a decrease in knee range of motion with the compression garment use.

Doan et al. (2003) also determined that there was a reduction in muscle oscillation both longitudinally and anterior to posteriorly. The reduction of muscle oscillation has been found to enhance performance, by reducing muscular fatigue and enhancing technique throughout a repetitive jump test (Kraemer et al., 1998).

Electromyography (EMG) uses electrodes placed on the skin above the working muscles to determine the activation of the working muscle. Wang, McLaren, Leong, and des Ouches (2013) used EMG to determine the activation of the rectus femoris and gastrocnemius muscles with and without compression garments over those muscles. They had a small sample size, but were still able to find a significant decrease in muscle activation with the use of compression. They also noted that there were similar results whether they wore compression shorts or compression tights.

Fu, Liu, Zhang, Xiong, and Wei (2012) also found that the application of a high compression garment has a positive effect on lowering muscle activation during a dynamic strengthening program. The participants were strapped into a Contrex PM1/MJ biomechanical test-training system. This device allowed the participants to actively

contract the muscles to perform a concentric knee extension exercise. The participants performed three different tests on this system including 60 degrees/s knee extension, 300 degrees/s knee extension, and an isometric test. At the slower speed of 60 degrees/s, there was a significant decrease in muscle activation along with a higher EMG mean power frequency.

Sixty Meter Sprint

Researchers have examined how compression garment use affects speed in short sprints from 20-60 m sprints. The 60 m sprint is most useful, since maximum velocity is reached between 40-60 m in non-elite sprinters (Makala, 2007). The use of a 20 meter sprint does not give the participants enough time to get to maximum speed. Doan et al. (2003) had the participants in their study perform a 60 m sprint while wearing or not wearing compression garments. They did not find any statistical difference in sprint time with the use of a lower-body compression garment.

Summary

The current literature presents multiple ideas that the use of compression should help with performance. The primary findings relevant to this study are that the use of compression garments create a decrease in muscle oscillation which will decrease muscle fatigue and muscle damage. The use of compression garments was also found to decrease muscle activation without affecting sprinting on a treadmill or contracting through a range of motion. The decrease in muscle damage by decrease in muscle oscillation has also been found to decrease biomarkers associated with muscle damage and recovery such as lactate accumulation and edema. In order to fully test a participant's speed they

need to be able to reach top speed which was determined by Mackala (2007) to be reach between 50-60 m in non-elite sprinters.

CHAPTER 3

METHODS

The purpose of this study was to examine the effect of thigh compression wraps on 60 m sprint performance in a physically active population. Compression garments have been used to prevent injury, increase muscle and skin temperature, and reduce post-exercise recovery time and muscle soreness. Compression garments have also been used to enhance short sprint performance. Compression wraps, on the other, are typically used to treat or prevent injury. The use of compression wraps to enhance sprint performance has never been studied.

Participants

Prior to recruiting study participants, the procedures of the study were approved by the SUNY Cortland Institutional Review Board (Appendix A). Physically active out-of-season SUNY Cortland athletes as well as physically active SUNY Cortland graduate students were recruited as potential participants in the study. At the initial meeting with potential participants, the researcher verbally described the study and its risks. Those who were still interested then read and signed an informed consent (Appendix A). They then completed a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix B) and a lower extremity injury questionnaire (Appendix C). The responses to the PAR-Q and lower extremity injury questionnaire were used to exclude potential participants due to current or previous lower extremity injuries or because of contraindications for participating in physical activity.

An *a-priori* power analysis was conducted for sample size estimation with alpha (α) set to .05 and estimate of power set at 0.75. With these parameters, the projected

sample size needed to achieve a moderate effect was approximately 30 (GPower 3.1.9.2). The actual number of participants was only 26. The desired sample size was not achieved because of the unanticipated number of potential participants excluded due to their lower extremity injury histories.

The 26 participants who completed the study included 19 women and 7 men. The subjects ranged in age from 18 to 29 years. Each participant's height and weight were measured at the initial meeting after participants had signed the informed consent and completed the PAR-Q and lower extremity injury questionnaire. Height was measured using an Actonel Stadiometer. Weight was measured using a digital scale (Weight-Health-o-Meter Professional Model 320 KL). Participant demographics are shown in Table 1.

Table 1.

Gender and Mean Height and Weight of Participants

Group	N	Height (+/-) SD (cm)	Weight +/- SD (kg)
Males	7	180.2 +/- 6.3	78.8 +/- 6.3
Females	19	157.3 +/- 5.1	66.9 +/- 9.1
Total	26	169.6 +/- 8.5	70.1 +/- 9.6

Procedures

The study consisted of two test sessions that took place on two separate days. During the initial meeting, the researcher scheduled dates and times for each subject for the first test session. The participants were instructed to keep the same physical activity

level the day prior to each test session to control the effects of fatigue or exercise.

Participants were also instructed to wear light color clothing to each test session for better visibility on the video record.

The test sessions took place on a 200 m indoor track. The 60 m sprints were run on one of the straight sections of the track. In the first test session the participants either performed the three control trials or three treatment trials. A control trial consisted of a 60 m sprint without thigh compression wraps. A treatment trial consisted of a 60 m sprint with thigh compression wraps. Order was randomly assigned by having the first participant draw a piece of paper from a hat. There were eight pieces of paper in the hat, four marked with an “X” for treatment and four marked with a “C” for control. The “X” or “C” mark on the piece of paper drawn by the first participant determined whether that first participant’s first test session consisted of three treatment trials or three control trials. The rest of the participants alternated between treatment and control based on the first participant’s session type. This guaranteed that the number of participants with treatment trials as their first test session would be equal to the number of participants with control trials as their first test session.

When participants arrived for a test session, their thighs were wrapped with compression wraps if their test session was a treatment session. If their test session was a control session, the compression wraps were not applied. The participants were then instructed to warm up on bicycle ergometer for 5 minutes at a cadence and work load of their choice.

After the warm up, each participant then lined up in a standing start position with the right foot forward and the left foot back. The right foot was positioned just behind a

strip of tape which marked the starting line of the 60 m. The participants were instructed to run the 60 m sprint as fast as they could and not stop until they passed a blue trash receptacle approximately 10 m past the 60 m mark. The researcher instructed the participant to “go whenever you are ready” and the participant began running within seconds after this instruction. Participants were not aware of the location of the actual 60 m mark.

Following the first and second 60 m sprint trials, the participants had five minutes of active rest to allow for full recovery of the ATP-PC system. During this five minute active rest period, the participants walked approximately one and three fifths laps (320 m) around the 200 m track. The participants walked one lap around the 200 m track to cool down after the final 60 m sprint trial.

The participants returned to the indoor track for their second test session two to seven days after their first test session. During the second test session, participants who completed the control trials in the first test session, were wrapped in the compression wraps and then completed the three 60 m sprints. Participants who completed the treatment trials in the first test session, completed the three 60 m sprints without compression wraps in the second test session. Other than the application or non-application of the compression wraps, the procedures followed for the second test session were identical to the procedures followed for the first test session.

Compression Wrap Application

When participants arrived at the indoor track for treatment trials, their thighs were sprayed with TUF-SKIN and wrapped with two new 6” by 10 yard compression wraps. Each compression wrap was wrapped around the thigh, going from distal to proximal, in

a crossing pattern on the anterior of the thigh as seen in Figure 1. The wrap started just above the knee. The first wrap was laid so that its inferior edge was in the fold of the knee. Each wrap of the compression wrap around the circumference of the thigh was counted and if the number of wraps on one leg differed from the other by more or less than 2 wraps, that wrap was removed and a new compression wrap was applied. Also, if a wrap was dropped and lost its original form and elasticity, a new wrap was used. The researcher applied pressure evenly throughout the wrap. If there was wrap left over after the thigh had been completely covered by the wrap then it was wrapped around the top of the leg without any compression. The wraps ends were then wrapped with elastic tape to prevent loosening of the wraps. Figure 1 shows the compression wrap in place on the leg.



Figure 1.

Frontal view of thigh showing the compression wrap in place.

60 m Time Measurement

The times for each 60 m sprint trial were derived from video recordings of each sprint trial. A Casio Exilim Pro EX-F1 digital camera operated in high speed video mode was used to video record each 60 m sprint trial. The camera was mounted on a tripod opposite the 60 m mark, approximately 30 m from the lane in which the participants sprinted. The camera height was adjusted to see the entire body of the sprinter. The camera frame rate was 300 frames/sec. The zoom lens was set between 36-432 mm to maximize the subject image size. The aperture of the camera was set to f/4.2 and its shutter speed was 1/400 s. The camera was panned to follow the participant for the whole 60 m as they performed each trial. The camera began recording before the researcher instructed the participant to “go whenever you are ready.” Recording was stopped after the participant ran past the 60 m mark. All videos were digitally recorded onto a Secure Digital High Capacity (SDHC) card.

After filming had been completed the SDHC card was removed from the camera. The digital video files on the SDHC card were transferred to a portable flash drive and then uploaded onto computer. Tracker, a video analysis and modeling program, was used to measure the total time to complete each 60 m sprint trial from the video files. Using the Tracker software, for each video file, the first frame in which the back foot (left foot) lost contact with the ground was identified and numbered as frame one. This was the starting frame of the 60 m sprint and timing began from this frame. To better identify this frame in the video recording, an LED video light was placed on the track near the start to illuminate the participant’s left foot. The ending frame of the 60 m sprint was the frame in which the chest of the participant crossed the 60 m mark. The 60 m mark was indicated

on the track by a white line. A pole was also placed at the 60 m mark on the opposite side of the sprint lane from the camera. The ending frame was more precisely identified as the frame when the participant's chest first obscured this pole in the video record. The number of frames between the first frame and ending frame of the 60 m sprint were counted in the Tracker software. This number of frames was then divided by the camera frame rate, 300 frames per second, to compute the time for each 60 m sprint trial in seconds.

Statistical Analysis

Descriptive statistics (means and standard deviations) were computed for each gender and for the whole group for height and weight. A Levene's test for equality of variance was also used to test for homogeneity among the male and female groups.

A paired samples t-test was used to compare average 60 m sprint time with the compression wraps and 60 m sprint time without the compression wraps for the entire group. Two additional paired samples t-tests were conducted to analyze differences in 60 m sprint times by compression wrap condition and control condition for males and for females. Level of significance was set to $\alpha = .05$ for all of these analyses.

A one-way ANOVA was conducted to determine if differences existed in 60 m sprint performance across the three trials for the control condition. Thus, trial number was the independent variable and 60 m sprint time was the dependent variable. Another one-way ANOVA examined differences in 60 m sprint time across trials for the treatment condition. For both ANOVAs, a Tukey post-hoc test was used to determine where differences lied among the three trials. Level of significance was set to $\alpha = .05$ for both ANOVAs.

Lastly, an average change score was computed for both the male and female participants separately. The average change score was calculated by subtracting the average treatment sprint time from the average control sprint time. An independent samples t-test was conducted to determine whether significant differences existed between the change scores of males and females. Level of significance was set to $\alpha = .05$ for this test.

CHAPTER 4

RESULTS

The purpose of this study was to examine the effect of thigh compression wraps on 60 m sprint performance in a physically active population. Previous research indicated that the use of compression garments results in no effect or a small improvement in sprint time. Twenty-six physically active participants completed two test sessions on two separate days, one week apart. During one test session, the treatment test session, participants completed three trials of a 60-m sprint with thigh compression wraps on each leg. During the other session, the control test session, participants completed three trials of the 60-m sprint without the thigh compression wraps. Control and treatment test sessions were randomized and counterbalanced. The primary hypothesis of the study was that the use of thigh compression wraps would not effect sprint performance. The results of this study are as follows.

Comparison of 60 m Sprint Times Between Conditions

The mean 60 m sprint time was 9.391 s for the three treatment (wrapped) trials and 9.292 s for the three control trials. The difference between the mean times was 0.0995 s. Table 2 shows the means of the 60 m sprint times by individual trial and by test session for male participants, female participants, and all participants. A paired-samples *t*-test between mean control sprint times and mean treatment sprint times showed that the difference between conditions was not significant ($t = 1.992$, $df = 25$, $p = .057$). The complete results of the *t*-test are shown in Table 3.

Table 2.

Mean 60 m Sprint Times by Test Session for Men, Women, and All Participants

	Control Session Times (s)				Treatment Session Times (s)			
	Trial 1	Trial 2	Trial 3	Mean	Trial 1	Trial 2	Trial 3	Mean
Male	8.314	8.190	8.281	8.262	8.262	8.141	8.183	8.195
Female	9.720	9.647	9.650	9.671	9.892	9.799	9.805	9.832
Total	9.326	9.255	9.281	9.292	9.453	9.353	9.368	9.391

Table 3.

Difference Between Control and Treatment 60 m Sprint Times

	Mean Difference (s)	Std. Deviation (s)	<i>t</i>	<i>df</i>	<i>sig</i>
Control Mean-Treatment Mean	-.0995	.255	-1.992	25	.057

Comparison of 60 m Sprint Times Among Control Session Trials

A one-way within-subjects ANOVA of the control session trials using the trial number as the independent variable and 60 m sprint time as the dependent variable showed a significant effect of trial number on 60 m sprint time ($F(1,24) = 2884.302, p < .05$). The results of the ANOVA are shown in Table 4. A Tukey post-hoc test showed no significance difference between the trials (1st and 2nd $p = .368$, 1st and 3rd $p = .261$, and 2nd and 3rd $p = 1.000$) as shown in Table 5.

Table 4.

ANOVA of Control Trial 60 m Sprint Times

Source	Type II Sum of Squares	<i>df</i>	Mean Square	<i>F</i>	<i>Sig.</i>	Partial Eta Squared
Intercept	6454.556	1	6454.556	2884.302	.000	.992
Error	53.708	24	2.238			

Table 5.

Pairwise Comparisons of Control Trial 60 m Sprint Times

Control Trials Compared		Mean Difference (s)	Std. Error (s)	<i>Sig.</i>	95% Confidence Interval for Difference	
					Lower Bound (s)	Upper Bound (s)
1	2	.064	.039	.368	-.040	.167
1	3	.081	.045	.261	-.038	.200
2	3	.018	.037	1.000	-.081	.116

Comparison of 60 m Sprint Times Among Treatment Session Trials

A one-way within-subjects ANOVA of the treatment session trials using the trial number as the independent variable and 60 m sprint time as the dependent variable showed a significant effect of trial number on 60 m sprint time, $F(1,25) = 2767.451$, $p < .001$). The results of the ANOVA are shown in Table 6. A Tukey post-hoc test indicated a statistically significant difference between the 1st and 2nd trials ($p = .047$), but there was

no difference between the 1st and 3rd trials ($p = .301$), and no difference between the 2nd and 3rd trials ($p = 1.0$). These results are shown in Table 7. Figure 2 displays the mean 60 m sprint times for each trial for both the control and treatment sessions.

Table 6.

ANOVA of Treatment Trial 60 m Sprint Times

Source	Type III Sum Squares	<i>df</i>	Mean Square	<i>F</i>	<i>Sig</i>	Partial Eta Squared
Intercept	6879.452	1	6879.452	2767.451	.000	.991
Error	62.146	25	2.486			

Table 7.

Pairwise Comparisons of Treatment Trial 60 m Sprint Times

Treatment Trials Compared		Mean Difference (s)	Std. Error (s)	<i>Sig.</i>	95% Confidence Interval for Difference	
					Lower Bound (s)	Upper Bound (s)
1	2	.100	.039	.047*	.001	.200
1	3	.085	.050	.301	-.043	.213
2	3	-.015	.034	1.000	-.101	.071

- $p < .05$

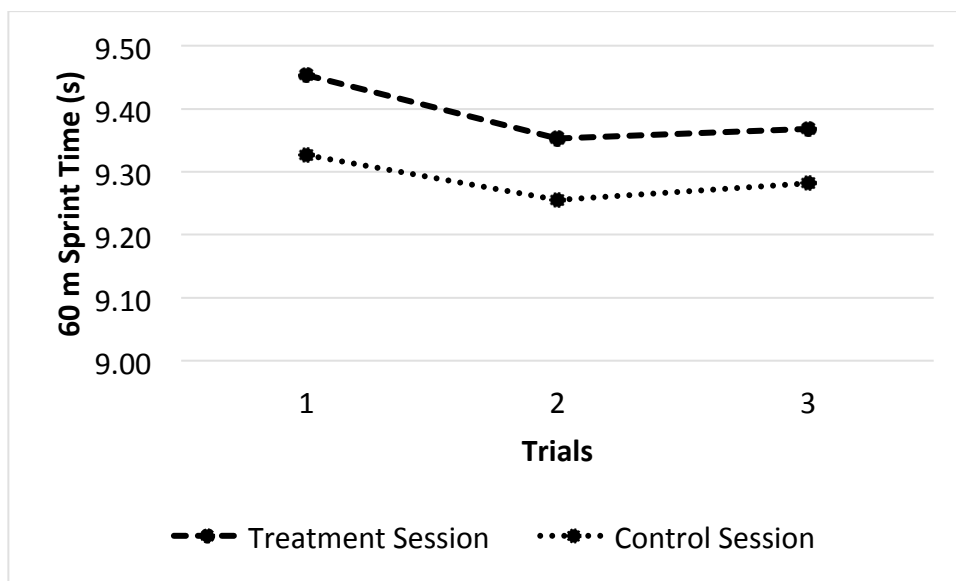


Figure 2. Mean 60 m sprint times for each trial and test session.

Comparison of 60 m Sprint Times Between Conditions for Women

A paired samples *t*-test between mean control sprint times and mean treatment sprint times for the 19 female participants showed a significant difference between control sprint times and treatment sprint times for women ($t = 3.441$, $df = 18$, $p = .003$). The female participants took 0.161 s longer to run the 60 m sprint in the treatment session (9.832 s) compared to the control session (9.671 s) as seen in Table 8.

Table 8.

Difference Between Control and Treatment 60 m Sprint Times for Women

	Mean Difference (s)	Std. Deviation (s)	<i>t</i>	<i>df</i>	<i>Sig</i>
Control mean.- Treatment mean	-.161	.203	-3.441	18	.003

Comparison of 60 m Sprint Times Between Conditions for Men

A paired samples *t*-test between mean control sprint times and mean treatment sprint times for the seven male participants showed no significant difference between the 60 m sprint times ($t = .52, df = 6, p = .601$). The male participants took 0.067 s longer to run the 60 m sprint in the control session (8.262 s) compared to the treatment session (8.195 s) as seen in Table 9. Unlike the women participants, who ran slower during the treatment trials, the male participants ran slightly faster during the treatment trials.

Table 9.

Difference Between Control and Treatment 60 m Sprint Times for Men

	Mean Difference (s)	Std. Deviation (s)	<i>t</i>	<i>df</i>	<i>Sig.</i>
Control mean- Treatment mean	.067	.319	.552	6	.601

Average Change Score

An average change score was calculated to determine the difference in mean sprint times from the control trial to the treatment trial. A negative number indicates a faster control time and a positive number indicates a faster sprint time for the treatment condition. There was a significantly greater change in 60 m sprint time from control to treatment in females (mean difference = $-.1607$ s) compared to the men (mean difference = $.0666$ s) as shown in Table 10. An independent *t*-test indicated the difference in change score between males and females was significant ($p = .041$) as shown in Table 11.

Table 10.

Average Change score for Men and Women

	Male or Female	N	Mean (s)	Std. Deviation (s)	Std. Error Mean (s)
Avg Change Score	Female	19	-.1607	.204	.047
	Male	7	.0666	.319	.121

Table 11.

Independent t-test Results between Average Change Scores of Men and Women

	<i>F</i>	<i>Sig.</i>	<i>t</i>	<i>df</i>	<i>Sig</i>
Equal Variances Assumed	2.314	.141	-2.161	24	.041

Homogeneity of the Groups

A Levene's test for equality of variances was conducted between the male and female groups to determine homogeneity of the groups. Results are presented in Table 12. The Levene's test for equality of variances determined that the groups variances were not significantly different ($p = .141$) even though the female group had more participants than the male group (19 versus 7, respectively). A significant ($p < .05$) Levene's test for homogeneity indicates that equal variances cannot be assumed.

Table 12.

Levene's Test for Equality of Variances

	<i>F</i>	<i>Sig.</i>
Average Change Score	2.314	.141

Summary

The results show that for the total sample (men and women combined), the use of compression wraps increased 60 m sprint times by about .1 s, but this difference was not statistically significant ($p = .057$). When the data from male and female participants were analyzed separately, the males' 60 m sprint times were not significantly different between conditions ($p = .601$), while the females' 60 m sprint times for the treatment condition were significantly slower ($p < .001$) than the control condition by about 0.16 s. The data were further analyzed to determine if the different sizes of the groups (male = 7, female = 19) affected the results. This analysis showed that variance in 60 m sprint times for the male and female groups were not statistically different ($p = .141$). Lastly, in each condition there was a statistically significant change among all three trials, but when separated only the treatment group was found to have a significant different sprint time between trial 1 and trial 2. The results indicate that the use of compression wraps had a significant negative effect on sprint performance for the female participants in this study.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The purpose of this study was to determine if using compression wraps on the thighs of physically active college students affected their 60 m sprint times. Although the effects of compression garment use on sprint performance have been studied, the effects of compression wraps on sprint performance have not been studied. In terms of practical implications, the results of this study could lead to the use of compression wraps in sports as an ergogenic aid.

The use of compression wraps had a slight negative effect on sprint performance in the combined group of men and women, slowing their 60 m sprint time by an average of 0.10 s over the average time for the control condition. This negative effect was not significant, however. Therefore, the original hypothesis that the compression wraps would have no effect on 60 sprint performance was supported.

Separate analyses of the male and female participants' data produced different results, however. The 19 women ran the 60 m sprints 0.161 s slower with their thighs compression wrapped than when their thighs were not compression wrapped. This difference was significant. The seven men on the other hand, ran the 60 m sprints 0.067 s faster when their thighs were compression wrapped than when their thighs were not compression wrapped. This difference was not significant. A comparison of the men's and women's changes in 60 m sprint times between the control and treatment sessions showed that the changes were significantly different between men and women. The effect of thigh compression wraps on 60 m sprint performance was different between men and

women. Women's sprint performance was negatively affected by thigh compression wraps, while men's sprint performance was unaffected by thigh compression wraps.

For the women in this study, the negative effect of using thigh compression wraps was not consistent with the literature regarding compression garments. Past research regarding the effects of compression garments on sprint performance found no effect or a small positive effect of compression garments on sprint performance. In the present study, the use of compression wraps on women produced the opposite effect. The results for the men in this study were in agreement with the previous research regarding the effects of compression garments on sprint performance.

Fu et al. (2012) and Wang et al. (2013) found a decrease in muscle activation as a result of compression. In the present study, muscle activation was not measured, but perhaps it could be related to the reason of why the women's 60 m sprint performance was negatively impacted by the use of compression wraps. If the muscles do not fire completely, muscle force production would be limited and this may have limited sprinting speed of the women in this study. This does not explain the men's results, however.

Doan et al. (2003) found a decrease in hip range of motion and knee range of motion as a result of compression garment use in sprinting. The decreased ranges of motion could lead to a decrease in stride length and thus a decrease in sprinting speed. Although not measured, the range of motion of the women's hip and knee joints may have been limited by the compression wraps in this study. This may have negatively affected their sprinting speed..

Rausch et al. (1985) found that compression wraps often had to be re-wrapped after a period of activity due to loosening. In the present study, from trial one to trial two of the compression wrap session, there was a significant decrease in time to complete the 60 m sprint. The 5-minute cycle ergometer warmup and the 5-minute walk after the first sprint could have resulted in loosening of the compression wraps and thus had a direct affect on the decrease in sprint time. There was also a decrease in sprint time between the first and second trials in the control session, but this decrease was not statistically significant. This shows that the first trial served as a warm up trial, and the second trial was the participants' fastest trial. The treatment group may have had the added benefit of the loosening of the compression wraps as well.

The findings of the current study suggest that the use of compression wraps has a negative effect on sprint performance in women in contrast to the use of compression garments which have little to no effect on sprint performance. This is the first known study investigating the performance enhancing effects of compression wraps. Compression wraps are most commonly utilized by athletic trainers to aid injured athletes. Compression wraps are used to reduce swelling and to protect injured areas during athletic and non-athletic activity. The current study examined the use of thigh compression wraps. The thigh is often the site of injuries usually involving the hamstring or quadriceps muscle groups. Results of this study showed that the use of thigh compression wraps has a negative effect on sprint speed. Thigh compression wraps may protect injured hamstrings or quadriceps. The lowered activity of these muscle groups as a result of the compression wraps may provide some protection to the injured muscles from re-injury. Athletic trainers should be aware of how compression wrap treatments

affect performance. Athletic trainers should be prepared to explain the results of this study and justify why compression wraps may be warranted to prevent injury and speed healing.

In the current study there were several limitations that may have impacted the results. The number of participants, 29, was less than the 30 participants that were desired. There were many more female participants than male participants, so finding significant results for the men was unlikely. There was also limitation with the 60 m sprint time measurements. For some trials, it was difficult to determine the exact frame in the video record when a subject first lost contact with the ground at the start of a sprint trial. This uncertainty may have slightly affected the accuracy of the time measurement for sprint. Another limitation that could have affected the results was the loosening of the wraps during the warm up before the first trial and during the active recovery after the first trial. A final limitation was the compression placed on the wraps. The researcher was the only one who wrapped each participant's legs, but it still may not have been equal for each participant's leg or from participant to participant. There was a maximum difference in wrap count between a participant's legs of two wraps, but the compression between participants was only controlled by the compression wrapping skill of the researcher.

In conclusion, this study adds to the knowledge regarding the effects of compression on performance with the use of compression wraps. The current study shows that the use of compression wraps has a negative effect on sprint performance in females, which contradicts previous research on compression garments. Past research has found the use of compression garments had a small positive to no effect on performance.

There are several possible reasons for the decrease in sprint performance with the use of compression wraps. Such reasons could include a decrease in muscle activation, leading to a decrease in knee and hip range of (Doan et al., 2003) or loosening of the compression wraps (Rausch et al. 1985). The primary finding of this study is that the use of thigh compression wraps decreases sprint performance in females.

Future research should examine the effects of the use of compression wraps on various aspects of performance. Many studies have already examined the effects of compression garments use on performance, but the effects of compression wrap use on performance may be different. The different effects of compression wrap use on performance in men versus women should also be investigated further.

REFERENCES

- Astrand, P.O. & Rodahl, K. (1977). *Textbook of Work Physiology*, New York: McGraw-Hill.
- Augst, G., Liberda, M., & Riedel, J. (1997). *U.S. Patent No. 5,616,387*.
- Bergh, U. and Ekholm, B. (1979). Influence of muscle temperature on maximal strength and power output in human skeletal muscles. *Acta Physiologica Scandinavica*, *107*, 33-37.
- Born, D.P., Sperlich, B., & Holmberg, H.C. (2013). Bringing light into the dark: effects of compression clothing on performance and recovery. *International Journal of Sports Physiology and Performance*, *8* (1), 4-18.
- Borras, X., Balias, X., Drobic, F., Til, L., Turmo, A., & Valle, J. (2011). Effects of lower body compression garment in muscle oscillation and tissular injury during intense exercise, *Portuguese Journal of Sport Sciences*, *11* (Suppl. 2) 685-688.
- Bringard, A, Perrey, S, & Belluye, N. (2006). Aerobic energy cost and sensation during submaximal running – positive effects of wearing compression tights. *International Journal Sports Medicine*, *27*, 373–378.
- Bringard, A., Denis, R. , Belluye, N., & Perrey, S. (2006). Effects of compression tights on calf muscle oxygenation and venous pooling during quiet resting in supine and standing positions. *Journal of Sports Medicine and Physical Fitness*, *46*, 548-554.
- Doan, B.K., Kwon, Y., Newton, R.U., Shim, J., Popper, E. M., Rogers, R.A., Bolt, L.R., Robertson, M., & Kraemer, W.J. (2003). Evaluation of a lower-body compression garment. *Journal of Sports Sciences*, *21*, 601-610.

- Duffield, R., & Portus, M., (2007). Comparison of three types of full-body compression garments on throwing and repeat-sprint performance in cricket players. *British Journal of Sports Medicine*, *41*, 409-414.
- Duffield, R, Cannon, J, & King, M. (2010). The effects of compression garments on recovery of muscle performance following high-intensity sprint and plyometric exercise. *Journal of Science and Medicine in Sport*, *13*,136-140.
- Fu, W., Liu, Y., Zhang, S., Xiong, X., & Wei, S. (2012). Effects of local elastic compression on muscle strength, electromyographic responses in the lower extremity. *Journal of Electromyography and Kinesiology*, *22*, 44-50.
- Higgins, T., Naughton, G., & Burgess, D. (2009). Effects of wearing compression garments on physiological and performance measures in a simulated game-specific circuit for netball. *Journal of Science and Medicine in Sport*, *12*, 223-226.
- Houghton, L., Dawson, B., & Maloney, S. (2009). Effects of wearing compression garments on thermoregulation during simulated team sports activity in temperature environmental conditions. *Journal of Science and Medicine in Sport*, *12*, 303-309.
- Jonker, M.J., de Boer, E.M., & Bezemer, P.D. (2001). The oedema-protective effect of Lycra® support stockings. *Dermatology*, *203*, 294-298.
- Kraemer, W., Bush, J., Bauer, J., Triplett-McBride, T., Paxton, N., Clemson, A.,...Newton, R. (1996). Influence of compression garments on vertical jump performance in NCAA Division I volleyball players. *Journal of Strength and Conditioning Research*, *10* (3), 108–83.

- Kraemer, W. J., Bush, J. A., Newton, R. U., Duncan, N. D., Volek, J. S., ., Denegar, C. R.,...Sebastianelli, W. J. (1998). Influence of compression garment on repetitive power output production before and after different types of muscle fatigue. *Sports Medicine, Training and Rehabilitation*, 8, 163–84.
- Kraemer, W. J., Bush, J. A., Wickham, R. B., Denegar, C. R., Gomez, A. L., Gotshalk, L. A.,...Sebastianelli, W. J. (2001). Influence of compression therapy on symptoms following soft tissue injury from maximal eccentric exercise. *Journal of Orthopaedic & Sports Physical Therapy*, 31 (6), 282–90.
- Mackala, K. (2007). Optimization of performance through kinematic analysis of the different phases of the 100 metres. *International Association of Athletics Federations*, 22:2; 7-16.
- MacRae, B. A., Cotter, J.D., & Laing, R.M. (2011). Compression garments and exercise: garment considerations, physiology and performance. *Sports Medicine*, 10, 815-843.
- Rausch, R., & Khalili, A. (1985). Air sprint in preprosthetic rehabilitation of lower extremity amputated limbs. *Journal of the American Physical Therapy Association and Royal Dutch Society for Physical Therapy*, 65, 912-914.
- Sargeant, A.J. (1987). Effect of muscle temperature on leg extension force and short-term power output in humans. *European Journal of Applied Physiology and Occupational Physiology*, 56, 693-698.
- Wang, P., McLaren, J., Leong, K., & des Ouches, P. (2013). A pilot study: Evaluations of compression garment performance via muscle activation tests. *Procedia Engineering*, 60, 361-366.

Appendix A

MEMORANDUM



To: Kevin Ostempowski
Peter McGinnis

From: Amy Henderson-Harr, Reviewer *on behalf of*
Institutional Review Board

Date: 4/16/15

RE: Institutional Review Board Approval

In accordance with SUNY Cortland's procedures for human research participant protections, the protocol referenced below has been approved for a period of one year:

Title of the study: The effect of upper leg wraps on sprint performance in an athletic population

Level of review: Expedited	Protocol number: 141531
----------------------------	-------------------------

Project start date: Upon IRB approval	Approval expiration date*: 4/15/16
---------------------------------------	------------------------------------

* Note: Please include the protocol expiration date to the bottom of your consent form and recruitment materials.

For more information about continuation policies and procedures, visit
www.cortland.edu/irb/Applications/continuations.html

The federal Office for Research Protections (OHRP) emphasizes that investigators play a crucial role in protecting the rights and welfare of human subjects and are responsible for carrying out sound ethical research consistent with research plans approved by an IRB. Along with meeting the specific requirements of a particular research study, investigators are responsible for ongoing requirements in the conduct of approved research that include, in summary:

- obtaining and documenting informed consent from the participants and/or from a legally authorized representative prior to the individuals' participation in the research, unless these requirements have been waived by the IRB;
- obtaining prior approval from the IRB for any modifications of (or additions to) the previously approved research; this includes modifications to advertisements and other recruitment materials, changes to the informed consent or child assent, the study design and procedures, addition of research staff or student assistants, etc. (except those alterations necessary to eliminate apparent immediate hazards to subjects, which are then to be reported by email to irb@cortland.edu within three days);
- providing to the IRB prompt reports of any unanticipated problems involving risks to subjects or others;
- following the principles outlined in the Belmont Report, OHRP Policies and Procedures (Title 45, Part 46, Protection of Human Subjects), the SUNY Cortland College Handbook, and SUNY Cortland's IRB Policies and Procedures Manual;
- notifying the IRB of continued research under the approved protocol to keep the records active; and,
- maintaining records as required by the HHS regulations and NYS State law, for at least three years after completion of the study.

Institutional Review Board
Page 2

In the event that questions or concerns arise about research at SUNY Cortland, please contact the IRB by email irb@cortland.edu or by telephone at (607)753-2511. You may also contact a member of the IRB who possesses expertise in your discipline or methodology, visit <http://www.cortland.edu/irb/members.html> to obtain a current list of IRB members.

Sincerely,

A handwritten signature in black ink, appearing to read "Amy Henderson-Harr". The signature is fluid and cursive, written over a light blue horizontal line.

Amy Henderson-Harr, Reviewer *on behalf of*
Institutional Review Board
SUNY Cortland

Appendix B
INFORMED CONSENT

You are invited to participate in a research study conducted by Kevin Ostempowski, a graduate student in the Kinesiology Department at SUNY Cortland. He requests your informed consent to be a participant in the study described below. *If at any time you have any questions about any aspect of the project, please feel free to ask.*

Purpose and Procedures of the Study:

The purpose of the study is to determine if using compression wraps on an athlete's thighs affects the athlete's 60 m sprint performance. If you agree to participate, you will be asked to attend an informational meeting and two test sessions. The informational meeting and the two test sessions will occur on three different days over a period of 10 days. The test sessions will occur a minimum of 2 days apart. At the informational meeting, this informed consent form will be given to you and the study will be described to you. If you choose to sign this informed consent, your height and weight will be measured and you will be asked to complete a physical activity readiness questionnaire (PAR-Q). You will also be asked to complete a lower extremity injury questionnaire. Your responses to the PAR-Q and the lower extremity injury questionnaire will determine whether or not you qualify to be a participant in the study.

If you do qualify to continue participating in the study, you will be asked to attend two test sessions. During each test session you will be asked to run three 60 m sprints on a straight section of the indoor track in Lusk Fieldhouse. At one test session, your thighs will be wrapped with latex free compression bandages. At the other test session, your thighs will not be wrapped. Whether your thighs are wrapped during the first or the second test session will be randomly determined. During each test session you will warm-up for 5 minutes on a stationary bicycle prior to sprinting. Following this warm-up, you will walk to the starting line of the 60 m sprint. When the investigator calls out "Ready", you will assume a standing position and begin the 60 m sprint when you are ready. You will then sprint as fast as you can for a distance of 60 m. The end of the 60 m is clearly marked on the track. After the first two 60 m sprints, you will have a 5 minute recovery period before starting the next sprint. During this 5 minute recovery period, you will walk one and a half laps around the track before the next 60 m sprint. The same procedures will be followed for each of the three 60 m sprints. After completing the third 60 m sprint, the compression wraps will be removed from your legs and you can cool down.

During each of the three 60 m sprints, a panning video camera will record you sprinting for the full length of the 60 m. The video from this camera will be used to determine your time for the 60 m sprint. A second, fixed view, video camera will also record you for approximately the last 10 m of each 60 m sprint. The video record from this camera will be used to measure your stride length, stride frequency, and ranges of motion at the hip joints and knee joints for each sprint.

Before agreeing to participate in this study, you should know the following:

1. Freedom to withdraw

You are free to withdraw your consent at any time without penalty. Additionally, at any time, you may ask the researcher to destroy all video recordings of your performances, as well as any other personal data or information collected during the study.

2. Confidentiality of records

Confidentiality will be maintained by limiting access to your video records and your other personal data to only the principal investigator and the co-investigators. The digital video records of your sprints and the digital records of the measurements of your sprint performances will be saved on a flash drive that is stored in the locked cabinet in the principal investigator's office. The digital video records will also be stored on a digital flash memory cards that will also be stored in a locked cabinet in the principal investigator's office. Your name will not be used or associated in anyway with the file names assigned to these digital video and data records. The original hard copies of your completed PAR-Q, lower extremity injury questionnaire, and this signed consent form will be secured in a locked cabinet in the principal investigator's office or one of the co-investigator's offices. These records will be destroyed or erased after 3 years.

3. Length of participation

The informational meeting will take approximately 30 minutes. The two test sessions will each take approximately 25 minutes. The informational meeting and the two test sessions will occur on three separate days over a period of 10 days, and the two test sessions will take place a minimum of 2 days apart.

4. Risks of the study

The risks associated with the study are minimal but include those risks associated with sprint running. You will probably experience muscle soreness in your legs for one or two days following the test sessions. You may also experience discomfort associated with cardiovascular exercise.

5. Benefits expected

Your participation in this study may help determine if the use of compression wraps covering the thighs improves sprint performance. Improvement in athletic performance and recovery from exercise has been associated with the use of compression garments.

6. Contact information

If you have any further questions concerning the purpose or results of this study, you may contact Kevin Ostempowski at (716) 863-9576 or kevin.ostempowski@cortland.edu.

For questions about research at SUNY Cortland or questions/concerns about participant rights and welfare, you may contact Amy Henderson-Harr, IRB Administrator, P.O. Box 2000, Cortland, NY, 13045 (phone (607) 753-2511 or email irb@cortland.edu). In the event of an injury please contact the SUNY Cortland Health Center in room B-26 of Van Hoesen Hall at (607) 753-4811.

**I, _____, have read the procedures and description of the
research study**
(print your name)
**for which this consent is requested, I understand my rights, and I hereby consent to
participate in this study.**

Signature

Date

Researcher's Signature

Date

Appendix C

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of any other reason why you should not do physical activity?

If
you
answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT _____

WITNESS _____

or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.



© Canadian Society for Exercise Physiology

Supported by:



Health
Canada

Santé
Canada

1:12

continued on other side...

Appendix D

Lower Extremity Injury Questionnaire

Please answer the following questions either **YES** or **NO**.

1. Do you currently have any lower extremity injuries you are receiving treatment for? _____
2. Have you ever had any type of surgery to your Lower Extremities including: hips, knees, ankles, and feet? _____
3. Have you had a muscular strain to your lower extremities in the last calendar year? _____