THE EFFECTS OF TWO ANKLE BRACES ON SPRINT SPEED, AGILITY, AND VERTICAL JUMP HEIGHT IN HEALTHY FEMALE COLLEGIATE ATHLETES

A THESIS

Submitted to the Faculty of the School of Graduate Studies and Research of California University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Science

by

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CALIFORNIA, PA

THESIS APPROVAL

Graduate Athletic Training Education

We hereby approve the Thesis of

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Candidate for the degree of Master of Science

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<tr>
<td>4/19/06</td>
<td>Dr. Robert Kane</td>
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<td>4/19/06</td>
<td>Dr. Tom West</td>
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ACKNOWLEDGEMENTS

“Shoot for the moon, and even if you miss, you will land amongst the stars.” ~ Les Brown

This is something I have heard at home ever since I can remember. My mother and father have been there for me through everything and always believed I can achieve anything I put my mind to, and to them I am most thankful! My mom and dad have always listened to everything and not only been my parents but my friends! I am also very lucky to have two sisters, Sara and Shari. I love you both and want to thank you for your support. I will always be here for you. I would like to thank the rest of my family, especially my Grammy, Memere, and Pepere. They have supported my dreams and are always there for me.

I would like to thank my committee, Dr. Robert Kane, Dr. Rebecca Hess, and Dr. Tom West for their time, advice, and determination throughout the year. Dr. Kane was there to support me and believed in me through the year. I am truly thankful for all the support this year. I need to say a special thanks to Dr. Rebecca Hess. Dr. Hess has spent countless hours with me in her office answering all my questions. This thesis would not be possible without the extra time and help from each member of my committee.

I have an amazing group of friends and I am very thankful they have kept in touch through this year’s ups and downs. I want to thank all my friends, but I need to mention a few. I want to say a special thanks to Push, Hills, Christine, and Akeem. You guys have been there through the tough times as well as the happy times this year. You listened to me anytime and gave me a reason to smile when I couldn’t find one. Thank you so much for being good friends.

I also want to thank the female athletes here at Cal U and Norwich University who volunteered in my study. Thanks to Norwich University for allowing me to test athletes there, and thanks to the strength coach for allowing me to borrow equipment while there. I want to thank Peters Township High School for allowing me to borrow some equipment to perform my testing as well.

Last but not least, I want to thank the friends I have made here at Cal U. Super bowl time was awesome, and yes, the Steelers won while we were here. Good luck to all of you and I can’t thank you enough for helping me through this year. Always remember: “Life is a journey, not a destination.” Good luck on your journey!
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Ankle injuries are among the most common injuries in athletics today.\textsuperscript{1-12} Prophylactic ankle devices have become important for instability, support, and injury prevention. The current issue involving prophylactic devices is whether these devices inhibit functional performance at the expense of stabilization. Previous research has been inconsistent. A recent meta-analysis comparing seventeen studies determined that although prophylactic devices may inhibit performance, they provide a great deal of support, making them more practical than no device.\textsuperscript{1}

The purpose of a prophylactic ankle device is “to support the unstable ankle and to restrict inversion and eversion of the foot, without interfering with normal joint mechanics.”\textsuperscript{13(p172)} In this sense, a prophylactic device is applied to the ankle to provide support, prevent injury and/or reinjury, restrict joint motion, provide mechanical support, and limit trauma.\textsuperscript{3,4,6,8,12-17} The two most important concerns of prophylactic ankle devices are whether they: 1) restrict the active range of motion (AROM), which will limit movement and is thought to prevent injury, or 2) allow full normal AROM, but restrict movement when outside the normal AROM.\textsuperscript{4,14}
Prophylactic ankle devices provide external ankle support using many different materials, which leaves reason for further examination into how each different brace effects the ankle. While there are a variety of brands of prophylactic devices on the market and each has its own strengths and weaknesses, the two types of prophylactic ankle devices are semirigid and soft-shell braces (soft-shell braces were used in this study). Semirigid devices have two shells, which consist of different types of hardened plastic that fit over the medial and lateral aspects of the ankle. These provide more restriction in inversion and eversion. This study focused on two soft-shell prophylactic devices (Swede-O Universal and ASO), which are devices with no hard plastic pieces and can be made out of a variety of materials such as cloth (canvas) or rubber. These provide more restriction in the sagittal plane, limiting plantarflexion (PF) and dorsiflexion (DF) of the talocrural joint.

Since prophylactic devices can restrict AROM, if significant restrictions occur, the issue becomes the inhibition of athletic performance. The Active Ankle and Air-Stirrup (semirigid braces) have reportedly allowed full normal AROM while restricting motion outside the normal range of motion. A meta-analysis by Cordova et al found,
through reviewing numerous studies, that ankle inversion AROM is significantly restricted with semirigid devices.\textsuperscript{1}

The Swede-O Universal lace-up (a soft-shell brace) restricts AROM in speed exercises, specifically plantarflexion and dorsiflexion.\textsuperscript{1,2,4,18} Since the lace-up style brace restricts these motions, it has been shown to decrease the speed of a sprint due to push off which mainly involves PF and DF.\textsuperscript{1} Due to this restriction, an effect on vertical jump has also been reported, but not consistent throughout the literature.\textsuperscript{14,15}

Measuring functional activities are components of, and contribute to, athletic competition (the literature examines how functional activities effect the ankle). Injured and uninjured ankles have been compared in two meta-analysis’s, but the studies have not come to a conclusion of whether ankle bracing has an effect on functional performance.\textsuperscript{1,7} Lower body function is often assessed using functional-performance activities because they incorporate muscular strength, neuromuscular coordination, and joint stability.\textsuperscript{19} This is where the prophylactic bracing becomes an issue. An athlete will choose not to wear a prophylactic ankle device if they know it may inhibit their athletic performance. This is why
performance testing in functional activities is important in sports competition.

Commonly used functional performance tests are the shuttle run or single-leg hop.\textsuperscript{11,19} Functional performance testing focuses on balance, coordination, and joint position control.\textsuperscript{11} External prophylactic devices have been found to both obstruct normal functional performance as well as increase normal functional performance, so future research must be done using consistent methods and testing equipment as previous tests to make the results more easily comparable.\textsuperscript{1} That will make the testing and results more valid and reliable. To understand how the prophylactic devices effect the performance testing techniques, the techniques must be understood.

One of the most common movements in sport is running for speed, or a sprint.\textsuperscript{18} When doing functional testing, different types of braces should be tested to examine the effectiveness of each brace. This is where the controversy arises; some researchers have found no change in speed due to the prophylactic bracing,\textsuperscript{2-4} while others have found a decrease in sprint performance.\textsuperscript{1} One way to resolve this issue is to determine the effect size, which “is a standardized measure of change associated with treatment,”\textsuperscript{7(p172)} which takes an average of the different
experimental and control groups scores and divides this by the standard deviation for the groups. Another way to resolve this issue would be to have a testing protocol followed by everyone doing a specific type of test. If the 40-yard dash were chosen, testing prophylactic ankle devices effects on speed should use this one functional activity instead of 20 foot to 60-yard sprints.

There are many functional performance-testing protocols for agility testing which is why it is difficult to compare results. While different aspects of agility have been measured, the important motions to test are inversion and eversion (lateral/medial motions) because most ankle injuries occur due to excessive inversion or eversion. When an athlete has an ankle injury, it is usually an inversion sprain since those are the most common. To test for this type of injury, we need to test side-to-side motion. The most common testing protocols are the T-test, SEMO agility test, the Shuttle Run, Figure-of-Eight Run, and the Four-Point Run. The purpose of agility activities is to test and examine quick directional changes, multidirectional movements, sprinting, acceleration and deceleration.

Vertical jump testing is the easiest way to test jumping height. This test is not difficult to administer,
but can be difficult in comparison. Most studies do not state exactly how the jump was performed.

Overall, functional activities such as the 40-yard Dash, the T-test for agility, and the vertical jump test are valid and reliable measures of how a brace can effect a test of speed (velocity), quickness in change of direction, and the height of a jump respectively.\textsuperscript{2,3,5,21,22} Although there is much conflict on whether prophylactic ankle braces positively or negatively effect the ankle and resulting functional activity, the literature supports that in most cases, there is some type of effect.

The purpose of this study was to examine whether prophylactic ankle devices effect functional performance. The following questions were addressed: 1) Will there be any difference in sprint speed when wearing a prophylactic ankle device as compared to wearing no device? 2) Will there be any difference in agility time in subjects with or without a prophylactic ankle devices compared to no device? 3) Will there be any difference in vertical jump height in subjects with or without a prophylactic ankle device compared to no device?
METHODS

The purpose of this study was to determine the effects of two ankle braces on sprint speed, agility, and vertical jump height in healthy collegiate female athletes. This section includes the following subsections: Research Design, Subjects, Preliminary Research, Instruments, Procedures, Hypotheses, and Data Analysis.

Research Design

A quasi-experimental within-subject research design was used for this study. The independent variable was the different conditions (the Swede-O Lace Up Ankle Lok® brace condition, the Ankle Stabilizing Orthosis® (ASO) brace condition, and no brace condition). The dependent variables were: (1) sprint speed in a 40-yard dash, (2) T agility test, and (3) vertical jump height. The study was conducted on three days with each subject tested under all three conditions (all dependent variables were tested each day). The researcher was the only one to fit the braces, and the subjects wore the same sneakers for each day of testing. A convenient sample of NCAA Divisions II and III athletes were used, limiting the generalization of results.
The strength in the subjects of this study was that they served as their own control group.

Subjects

The subjects (N=30) in this research study were uninjured female collegiate NCAA Divisions II and III athletes from California University of Pennsylvania (Division II) and Norwich University (Division III). The subjects were a sample of convenience and included volunteers with no coercion or influence from the coaching staff. The researcher went to each of the following teams and asked for a sample of volunteer athletes from softball, volleyball, soccer, rugby, and swimming. The subjects were screened for previous history of lower extremity injuries and those who have had these injuries in the past six months were excluded from volunteering. Each subject completed an Informed Consent (Appendix C1) before participating in the study. A Demographic Information Sheet (Appendix C2) was collected (sport, position, age, height, weight, whether orthotics are worn, previous surgery to the lower extremity, and previous use of ankle braces in high school or college) from each subject. No names were included in the study.
Preliminary Research

Preliminary research was done to determine how long the testing protocol and brace fitting would take. Three college-aged graduate students were the subjects for the pilot study. Each subject was properly fitted with both braces by the researcher. The pilot testing helped determine how long each testing day (the three trials of each functional activity) would take per subject. The pilot testing also allowed the researcher to become familiar with the testing procedures.

Instruments

The following instruments were used in this study. A Demographic Information Sheet (Appendix C2) was used to document the subject’s sport, position, age, height, weight, whether orthotics are worn, previous surgery to the lower extremity, and previous use of ankle braces in high school or college. No subject’s names were recorded for use in this study; instead each subject was assigned a subject number. This information gave the researcher a background to the subject’s who are being testing with the following tools.
Brace Type

The two bracing conditions that were examined were the Swede-O Lace Up Ankle Lok® (Swede-O-Universal, North Branch, Minn), and the Ankle Stabilizing Orthosis® (ASO). The Swede-O Lace Up Ankle Lok® is a soft-shell brace that is used to prevent inversion ankle sprains. It is also easy to apply and easy to slip on or off with laces in the front and an elastic backing (Appendix C3). This brace is known to limit AROM, specifically dorsiflexion and plantarflexion. The ASO is constructed of Cool Flex material with polyester-cotton laces that provide stability. This soft-shell prophylactic ankle brace has two nylon figure-eight straps that wrap around the foot like a taping heel lock to provide extra support (Appendix C3).

Both the Swede-O and ASO prophylactic devices are used to prevent ankle injuries. These braces fit to the ankle and cause less skin irritation due to the material from which they are made (Appendix C3). Both the Swede-O and ASO are considered level III braces and are indicated for “advanced protection and support features” out of IV categories.
Testing Instrumentation

The testing instruments were the 40-yard dash, the T-test for agility, and the vertical jump. The Speed Trap II Timer™ (Appendix C4), and the Just Jump System™ vertical jump-testing device (Appendix C4) were used to measure those functional activities. The same researcher applied both bracing conditions and administered the functional tests. Subjects performed all tests under both braces and no brace conditions.

The 40-yard dash was used to test sprint speed and velocity. It is a valid and reliable tool, which was used to measure sprint velocity.\textsuperscript{2,18,22} This test was done in the gymnasium in Hamer Hall at California University of Pennsylvania and in the field house at Norwich University. The 40-yard dash was scored using the time recorded from the Speed Trap II Timer™ (Appendix C4). The Speed Trap II Timer™ was used to measure the rate of speed in seconds of each athlete with each bracing condition (including the no brace condition). The Speed Trap II Timer™ is more accurate than a stopwatch because the timer starts when the subject steps on or releases their foot from the photocell.\textsuperscript{24} This is also accurate to 1/100\textsuperscript{th} of a second as a stopwatch, but researcher error is eliminated.
The T-test for agility is a test requiring the athlete to sprint forward, backward, and move laterally to both sides as quickly as possible. The subject will sprint forward first, then has the choice to go either direction laterally, then the other lateral direction, and then backward. This was scored by time in seconds using the Speed Trap II Timer™ to determine how quickly the athlete completes the T-test (changing direction), where a decrease of time will be considered better performance. The T-test has been used in many studies with a repeated reliability of 0.98.\textsuperscript{22} The T-test has been supported to measure leg speed and secondly, leg power and agility.\textsuperscript{22}

The vertical jump test has been used to measure functional power. The Just Jump System™ is used to measure the distance of the vertical jump, using a 28-in square mat connected to a hand-held computer.\textsuperscript{24} The jump is scored by the height of the jump giving the researcher a good idea as to the explosive power of the legs. This device is accurate and was shown to be valid and reliable. Test trials were done with children and adults yielding a correlation of $r = .69$ in children for bilateral jumps and $r = .73$ to .91 for a single-leg jump with the non-dominant leg in adults.\textsuperscript{25}
Procedures

The researcher received approval from the California University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (IRB) (Appendix C5). The researcher sent a copy of the IRB approval to Norwich University which allowed the researcher to test at Norwich University in Northfield, Vermont, as well as California University in California, Pennsylvania. Upon approval, the researcher went to each female athletic team at California University of Pennsylvania and Norwich University, asking for volunteers who have not had any lower extremity injury in the previous six months to participate in this study. The researcher explained the purpose of the research to each subject when asking for volunteers. At the first testing date, each subject signed an Informed Consent Form (Appendix C1). After signing the informed consent, each subject filled out the Demographic Information Sheet (Appendix C2).

Each subject was informed they must be tested on three separate days forty-eight hours (two days) apart. They must decide when this would be best (out of the two week testing period). Each subject was correctly fitted with braces (for both ankles) on the first testing day. Once
the subjects’ were fitted for braces on both ankles, a random assignment to functional testing and treatment groups was performed. The subjects’ were randomly assigned to the testing order 40-yard Dash (S), T-test for Agility (A), and the Vertical Jump (V) test. Then each subject was randomly assigned to the order of the conditions; control with no brace (NB), Swede-O bracing (SB), or ASO bracing (AB).

A warm-up was done before performing the functional testing each day. Each subject began with a five-minute bike ride, followed by a dynamic warm-up (including high knees, butt kicks, kicking legs straight ahead, jogging backwards, and side shuffles). The dynamic warm-up is multiplanar, and more functional while requiring neuromuscular control, which is preferred over static stretching before activity.  

Subjects were individually introduced to the 40-yard dash and were given a practice trial at 50% to 75% of their fastest speed to become accustomed to the distance and the Speed Trap II Timer™. The athlete began when they feel ready and ran as fast as possible through the finish line where the researcher was waiting.

Each subject performed three trial runs with a two-minute rest between trials and a five-minute rest between
functional tests. The results were recorded in the data collection form for speed (Appendix C6). The best speed score was taken for data analysis, and the protocol was the same for all conditions (WB, SB, and AB).

Subjects were individually introduced to the T-test for agility. The researcher ran through the series to show the subject what to do and then the subject jogged through the series to familiarize herself with it. The T-test consists of a sprint ten-yards, touch the ground, shuffle laterally five-yards to one side, touch the ground, shuffle ten-yards laterally to the other side, touch the ground, shuffle five-yards back to the middle, touch the ground, and run backwards 10 yards to the starting line.²² The Speed Trap II Timer™ was used to measure how long it takes each subject to complete the test in seconds. The subject began when she was ready and the timer stopped when she passed the last cone (where the researcher was waiting).

Each subject performed three trial runs with a two-minute rest between trials and a five-minute rest between functional tests. The results were recorded in the data collection form for agility (Appendix C6). The best agility score was taken for data analysis, and the protocol was the same for all conditions (WB, SB, and AB).
Subjects were individually introduced to the vertical jump test. The higher a person can jump, the more power they contain. The researcher showed the subject how to perform the vertical jump test, and then allowed the subject a test trial. The researcher allowed the subjects to squat down and jump straight up. The subjects were told to try to keep their weight back, keeping their knees over their feet. If the subject jumped forward or held their feet in the air (does not go straight up and down), the jump was not counted and the subject had to jump again. The vertical jump was measured by the Just Jump System™, which measures the height in inches of each jump.

Each subject performed three trial runs with a two-minute rest between trials and a five-minute rest between functional tests. The results were recorded in the data collection form for vertical jump (Appendix C6). The best vertical jump score was taken for data analysis, and the protocol was the same for all conditions (WB, SB, and AB).
Hypotheses

The following hypotheses were based on the literature reviewed and the intuition of the researcher when developing this study.

1) There will be a difference in sprint speed when wearing a prophylactic ankle device as compared to wearing no device.

2) There will be no different in agility time when wearing a prophylactic ankle device as compared to wearing no device.

3) There will be a difference in vertical jump height when wearing a prophylactic ankle device as compared to wearing no device.
Data Analysis

A Repeated Measures MANOVA was used to analyze all three hypotheses involving the bracing condition (NB, SB, AB) and the dependent variables (S, A, V). The level of significance for this study was set at $< 0.05$ for all hypotheses. SPSS version 12.0 for Windows was used for the statistical analysis.
RESULTS

The purpose of this study was to determine if the Swede-O Ankle Lok® or Ankle Stabilizing Orthosis® ankle braces would have a significant effect on the sprint speed, agility, and vertical jump height in healthy female collegiate athletes. The following section contains the data collected through the study and is divided into three subsections: Demographic Information, Hypotheses Testing, and Additional Findings.

Demographic Information

Twenty female NCAA Collegiate Division II and III athletes from softball, volleyball, swimming, soccer, and rugby teams completed this study. The demographic information was collected to give the researcher a background of the subjects participating in the study.

The demographic information sheet was completed by each voluntary subject with the researcher present before participation in the study. The demographic information sheet asked each subject to provide the following information: sport, position, age, height, weight, whether orthotics are worn (if so they were worn in study), whether
the subject has had surgery to the lower extremity and if so what joint, and whether the subject has worn any ankle braces in high school or college.

There was a second part to the demographic sheet that was filled out at the completion of the study. The researcher was interested in ascertaining if the subject felt the ankle brace(s) affected the functional performance in sprint speed, agility time, and vertical jump height. The other questions asked were whether the subject felt the brace(s) were supportive and if they believed that the brace(s) prevented injury.

The twenty participants were female athletes from California University of Pennsylvania (Division II) and Norwich University (Division III). The subjects broken into sports categories were: eight softball players, three volleyball players, two swimmers, three soccer players, three rugby players, and one soccer/rugby player. The demographic information can be seen in Table 1.
Table 1. Demographic Information of Subjects by Sport

<table>
<thead>
<tr>
<th>Sport</th>
<th>N</th>
<th>Age M (SD)</th>
<th>Weight M (SD)</th>
<th>Height M (SD)</th>
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<td>Softball</td>
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<td>19.88 (1.46)</td>
<td>74.80 (2.77)</td>
<td>164.19 (15.11)</td>
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<tr>
<td>Volleyball</td>
<td>3</td>
<td>19.33 (1.16)</td>
<td>76.00 (3.27)</td>
<td>175.90 (18.08)</td>
</tr>
<tr>
<td>Swimming</td>
<td>2</td>
<td>19.50 (0.71)</td>
<td>76.19 (0.00)</td>
<td>175.70 (4.10)</td>
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<tr>
<td>Soccer</td>
<td>3</td>
<td>19.67 (2.08)</td>
<td>78.19 (1.32)</td>
<td>191.26 (19.02)</td>
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<tr>
<td>Rugby</td>
<td>3</td>
<td>19.67 (1.16)</td>
<td>75.05 (4.00)</td>
<td>175.13 (49.00)</td>
</tr>
<tr>
<td>Soccer/Rugby</td>
<td>1</td>
<td>20.00 (0.00)</td>
<td>75.05 (0.00)</td>
<td>161.29 (0.00)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>19.70 (1.26)</td>
<td>75.82 (2.82)</td>
<td>172.64 (22.48)</td>
</tr>
</tbody>
</table>

The California University of Pennsylvania sample consisted of three softball players, one volleyball player, one swimmer, and one soccer player. The rest of the subjects came from Norwich University.

Of the twenty subjects, eight had prior experience wearing ankle braces of some type in high school or college. Only three of the twenty subjects currently wore orthotics, and only three of the twenty subjects have had surgery on the lower extremity in their life. No subjects had any lower extremity injury or surgery within the past six months.
Hypotheses Testing

The following hypotheses were tested for in this study. All hypotheses were tested with the level of significance set at $\leq 0.05$.

A Repeated Measures MANOVA was calculated for all three hypotheses examining the effect of the condition (Swede-O Ankle Lok® (SB), Ankle Stabilizing Orthosis® (AB), and no brace (NB)) on the sprint speed, agility time, and vertical jump height. No significant effect was found ($\Lambda(6, 110) = .970, P > .05$).

Table 2. Repeated Measures MANOVA for Effect of Ankle Bracing on Sprint Speed, Agility Time, and Vertical Jump Height

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>P</th>
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<td>Group Wilks' Lambda</td>
<td>0.97</td>
<td>0.282</td>
<td>6</td>
<td>110</td>
<td>0.944</td>
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Hypothesis 1: There will be a difference in sprint speed when wearing a prophylactic ankle device as compared to wearing no device.

Conclusion: Hypothesis 1 was not supported (Table 3). Sprint speed was not affected by bracing condition.
Hypothesis 2: There will be no difference in agility time when wearing a prophylactic ankle device as compared to wearing no device.

Conclusion: Hypothesis 2 was supported (Table 3). Agility time was not affected by the bracing condition.

Hypothesis 3: There will be a difference in vertical jump height when wearing a prophylactic ankle device as compared to wearing no device.

Conclusion: Hypothesis 3 was not supported (Table 3). Vertical jump height was not affected by the bracing condition.

Table 3. Descriptive Statistics for Speed, Agility, and Vertical Jump Height according to Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Std. Deviation</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Brace</td>
<td>6.75</td>
<td>0.54</td>
<td>20</td>
</tr>
<tr>
<td>Swede-O Brace</td>
<td>6.85</td>
<td>0.51</td>
<td>20</td>
</tr>
<tr>
<td>ASO Brace</td>
<td>6.71</td>
<td>0.98</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>6.77</td>
<td>0.70</td>
<td>60</td>
</tr>
<tr>
<td>Agility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Brace</td>
<td>9.07</td>
<td>0.95</td>
<td>20</td>
</tr>
<tr>
<td>Swede-O Brace</td>
<td>9.08</td>
<td>1.03</td>
<td>20</td>
</tr>
<tr>
<td>ASO Brace</td>
<td>9.08</td>
<td>0.97</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>9.08</td>
<td>0.97</td>
<td>60</td>
</tr>
<tr>
<td>VJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Brace</td>
<td>17.02</td>
<td>2.03</td>
<td>20</td>
</tr>
<tr>
<td>Swede-O Brace</td>
<td>16.48</td>
<td>1.78</td>
<td>20</td>
</tr>
<tr>
<td>ASO Brace</td>
<td>16.87</td>
<td>1.87</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>16.79</td>
<td>1.88</td>
<td>60</td>
</tr>
</tbody>
</table>
Additional Findings

Following the testing of the hypotheses, further testing was conducted to determine if there was any relationship between the sport groups, age, height, weight, whether the subjects have worn orthotics or had previous surgery or injury. Testing was also done on the feeling the subjects had about their performance in each test wearing the prophylactic braces.

A Pearson correlation coefficient was calculated for the relationship between the testing variables and the demographic information. A moderate correlation was found between height and weight \((r(18)=.600, P = .005)\); and between those who have had surgery and the vertical jump height \((r(18)= -.459, P = .042)\).

The researcher also investigated whether previous bracing experience caused a change in results. A Repeated Measures MANOVA was calculated for all three hypotheses examining the effect of condition (Swede-O Ankle Lok® (SB), Ankle Stabilizing Orthosis® (AB), and no brace (NB)) on the sprint speed, agility time, and vertical jump height. No significant effect was found \((\Lambda(6,62) = .922, P > .05)\). This supports the idea that previous bracing does
not effect performance in functional activities compared to those with no previous bracing experience.

The second part of the demographic information sheet focused on whether the subject felt the bracing had any effect on performance (positive or negative), whether the bracing is supportive or prevents injury. This information is summarized in Table 4. Subjects were simply asked if the ankle brace had an effect on the functional tests; no direction (positive or negative) was given when asking this question.

Table 4. Frequency of Subjects’ Opinions on Bracing Effect

<table>
<thead>
<tr>
<th>Ankle Braces Effect:</th>
<th>Strongly Agree (1)</th>
<th>Agree (2)</th>
<th>Disagree (3)</th>
<th>Strongly Disagree (4)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprint Speed</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>2.45</td>
<td>0.69</td>
</tr>
<tr>
<td>Agility Time</td>
<td>1</td>
<td>13</td>
<td>5</td>
<td>1</td>
<td>2.30</td>
<td>0.66</td>
</tr>
<tr>
<td>Vertical Jump Height</td>
<td>3</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>2.45</td>
<td>0.95</td>
</tr>
<tr>
<td>Bracing is Supportive</td>
<td>7</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>1.70</td>
<td>0.57</td>
</tr>
<tr>
<td>Bracing Prevents Injury</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td>2.00</td>
<td>0.46</td>
</tr>
</tbody>
</table>

A Pearson correlation coefficient was calculated for the relationship between how the subjects felt the bracing affected their performance. A moderate correlation was found for the following variables: between how the subject
felt her agility time would be and how the subject felt about the braces being supportive ($r(18) = .533, P = .016$); between how the subject felt the braces effected their sprint speed and how the braces effected their vertical jump height ($r(18) = .564, P = .010$); and how the braces effected their sprint speed and agility time ($r(18) = .619, P = .004$).
The following section is divided into three subsections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

The purpose of this study was to investigate whether the Swede-O Ankle Lok® or Ankle Stabilizing Orthosis® ankle braces had an effect on sprint speed, agility, and vertical jump height in healthy NCAA Division II and III female athletes. The researcher wanted to investigate this topic because a controversy exists whether prophylactic bracing inhibits performance. This study determined these two braces have no effect on sprint speed, agility, and vertical jump height. Neither brace showed an effect or change in the speed or vertical jump height compared to the control group, causing the researcher to find no significance.

The researcher hypothesized the braces would effect sprint speed and vertical jump height, while having no effect on agility time. The results did not support the conclusions that the braces would affect sprint speed or
vertical jump height but did support the hypothesis there
would be no effect on agility time. What the researcher
found is that there was no significant effect on any of the
functional performance tests with the braces compared to
without the braces.

A majority of the subjects in this study stated that
they felt they were working harder when wearing a
prophylactic device than when they were not wearing one.
This was very interesting because that means that
consciously or subconsciously, these female athletes
perceived they were working harder when wearing either of
the braces to keep their performance consistent. The
results of this study showed that these female athletes
worked harder to provide consistent results. The
researcher feels these female athletes overcame the
psychological issue of wearing a prophylactic brace and
just did their best in each functional performance test.
This is the main reason the researcher feels the results
came out so closely and the reason there was no significant
difference in performance when wearing a brace compared to
no brace.

The results of this study supported the opinions of
the meta-analysis completed by Cordova et al.¹ “It is our
opinion that the benefit in preventing injury outweighs the
possibility of substantial but small impairment of performance when athletes use external ankle support.\textsuperscript{1}

Cordova et al’s\textsuperscript{1} meta-analysis found approximately 1% impairment on sprint speed testing, and found no significant effects in either agility time or vertical jump height throughout the seventeen studies reviewed.\textsuperscript{1} The results include male and female subjects, some healthy, some with CAI, along with athletes and non-athletes. That is why the current study looked at healthy female collegiate athletes. None of the previous studies reviewed by the researcher focused on this subject pool. A majority of the research on females was done by Beriau et al\textsuperscript{27} in the high school setting.

The meta-analysis by Cordova et al\textsuperscript{1} stated that in seventeen studies, only approximately 12% of these studies were done on females alone. Over half of these studies (53%) were also done on healthy athletes, but at different age and sport levels (high school and collegiate).\textsuperscript{1} One study by Beriau, using the Swede-O brace on agility performance used a subject pool of both male and female high school athletes. Only 25% of the high school athletes in this study were female.\textsuperscript{27} Beriau’s study was limited to only athletes with no history of ankle injury six months prior to participation and no past bracing experience.
This study showed there was a difference in performance with the Swede-O brace.\textsuperscript{27} This study was performed on high school athletes who are not at the same experience level, maturity level, or competition level as the athletes in the current study, which could be a reason why the results are different.

Although Beriau’s results conflict with the results of this study, Beriau et al\textsuperscript{27} also believed that bracing has very little if any effect on functional performance. This is good because prophylactic ankle devices have been proven to be cheaper than taping, so these devices can be used for a preventative and rehabilitative manner.\textsuperscript{8,14,16} From reviewing the literature, it is evident that bracing may have some effect on performance, but may be more prevalent in professional or elite athletes, where minimal changes make a large difference (eg: muscle strength bilaterally).

At the end of the study, each athlete filled out a questionnaire on how they felt about the braces used in the study. They were asked whether the braces had any effect each functional performance test, as well as whether the braces felt supportive and whether the subject felt the braces would prevent further injury. A majority of the subjects felt the braces were supportive and would prevent injury. This is very important because if athletes feel
the brace is supportive and will prevent injury, they will be more apt to wear the brace compared to no brace.

How an athlete feels about a prophylactic ankle device is very important as well. Chronic ankle instability (CAI) is usually a subjective measure of instability in the ankle joint.\textsuperscript{11,28} This means that how the athlete feels about their ankle being stable or unstable determines what is wrong with the ankle, so how the athlete feels about the devices worn to help support the ankle or prevent injury to the ankle is also a critical component. At least 75% of the subjects told the researcher the Ankle Stabilizing Orthosis\textsuperscript{®} was much more comfortable than the Swede-O brace. They stated they would wear no brace instead of wearing the Swede-O brace due to the discomfort of the brace. To eliminate the chance of brace discomfort due to improper fitting, the researcher fit all braces to the subjects according to the manufacturer’s instructions.

Both braces used in the current study were soft-shell braces. Soft-shell braces, specifically the Swede-O Universal brace have been found to restrict normal AROM in plantarflexion and dorsiflexion,\textsuperscript{4,14} while semirigid braces have been found to allow full normal AROM while restricting motion outside of the normal range.\textsuperscript{12} Inversion was also found to be restricted with the semirigid brace.\textsuperscript{1}
restriction of motion could cause discomfort to the athlete, which may cause the choice of not wearing the brace.

Conclusions

This study revealed that prophylactic ankle bracing has no effect on sprint speed, agility time, or vertical jump height in uninjured female collegiate NCAA Divisions II and III athletes. The athletes in this study performed the same for each condition in each functional test with or without the bracing condition present. However, the athletes felt the braces affected their performance. The subjects significantly agreed bracing is supportive and preventive. In this case, it might be wise for the athletic trainer needs to inform the athlete that bracing does not affect performance. Showing the athlete this is true will help them understand that they may be deceived by their feelings.

Recommendations

It is important for the Certified Athletic Trainer to understand a prophylactic ankle device can be worn during
sport without inhibiting performance. A prophylactic device may be worn to provide support as well for prevention and rehabilitation. The braces do not cause a change in performance, which is important for the Certified Athletic Trainer as well as for the athlete they are bracing. If the athlete knows this, they will be more comfortable wearing the brace.

Psychologically, the athletes who want to wear bracing for prevention but are unsure of the effects can be reassured the braces will not inhibit their performance. This generalization can not be assumed for all braces because a semirigid brace limits different motions than the soft-shell, so further testing should be done to ensure this is the same for all braces in all athletes (male or female).
REFERENCES


APPENDIX A

Review of the Literature
Ankle injuries are among the most common injuries in athletics today.\textsuperscript{1-12} Prophylactic ankle devices have become important for stability, support, and injury prevention. The current issue involving prophylactic devices is whether these devices inhibit functional performance at the expense of stabilization. This has been previously researched, but the results have been inconsistent. For example, a recent meta-analysis comparing seventeen studies, determined that although prophylactic devices may inhibit performance, they provide a great deal of support, making them more practical than no device.\textsuperscript{1} This literature review will examine prophylactic devices in the following sections: (1) Functional Anatomy and Instability of the Ankle, (2) The Use of Prophylactic Ankle Braces, and (3) Summary.

Functional Anatomy and Instability of the Ankle

The bones that make up the ankle are the distal end of the tibia and fibula, the talus, and the calcaneus. Articulations between these bones form the superior and inferior tibiofibular joints, the talocrural joint, and the subtalar joint.\textsuperscript{13,14} The superior tibiofibular joint allows minimal gliding, but is not of major concern in ankle injuries because it is in the knee area. The lateral
malleolus and the distal end of the tibia are the articulations that make up the inferior tibiofibular joint.\textsuperscript{13} The talocrural joint is considered the main ankle joint and acts as a hinge joint, and laxity of this joint is found in 75\% of subjects with a history of ankle sprains.\textsuperscript{10} This joint is formed by the distal tibia, the talus (trochlea surface),\textsuperscript{13} and the medial malleolus.\textsuperscript{13,15} This synovial joint allows plantar and dorsiflexion to occur.\textsuperscript{10} The subtalar joint is formed of the calcaneus and talus, which allow inversion, eversion, pronation, and supination.\textsuperscript{13,15} The subtalar joint and talocrural joint work very closely together because the movement between the talus and calcaneus (of the talocrural joint) helps establish the motion of the subtalar joint.\textsuperscript{15} Laxity in the talocrural joint leads to laxity in the subtalar joint in two-thirds of those with ankle instability.\textsuperscript{10}

The ligaments of the ankle, which provide static stabilization are commonly injured. The most common and well-known ligaments are the tibiofibular ligaments, which hold the tibia and fibula together. There are three ligaments on the lateral aspect of the ankle: the anterior talofibular ligament (ATF), which is the most commonly injured ligament of the ankle, the posterior talofibular ligament (PTF), and the calcaneofibular ligament (CF).\textsuperscript{13}
There is one major ligament on the medial side of the ankle, which has a fan shape, is called the deltoid ligament. It functions to resist eversion of the ankle. Even though it has deep and superficial fibers, it is considered one ligament.\textsuperscript{13}

The ankle is a complex joint in the sense that it has numerous articulations. Some of the movements of the foot and ankle are combined to make the joint more intricate. In the foot, there are the sub-talar and the mid-tarsal joints.\textsuperscript{15,16} Rearfoot motion is known as pronation and supination, but these are combinations of movements depending on whether there is an open or closed kinetic chain.\textsuperscript{14} Plantar flexion, eversion, and external rotation are the motions involved in closed kinetic chain pronation, while open kinetic chain pronation is a combination of dorsiflexion, eversion, and external rotation.\textsuperscript{10,14} Dorsiflexion, inversion, and internal rotation are the motions that contribute to closed kinetic chain supination, while open kinetic chain supination is a combination of plantar flexion, inversion, and internal rotation.\textsuperscript{10,14} Combinations of motion are considered functional anatomy. Sports are made up of functional activities, so knowing how these motions occur anatomically (especially the rearfoot motion) is important. Any injury to the ankle joint can
cause a difficulty in performing these motions, leading to instability.

Factors Contributing to Chronic Ankle Instability

Instability is a major issue in the ankle because once the ankle is injured; there is usually instability. Kinesthesia and Joint Position Sense (JPS) are said to contribute to chronic ankle instability (CAI). The issue with testing and trying to find more efficient ways to address CAI is that it is defined differently and tested for differently. Many testers use what the athlete feels as a way to measure CAI, or in the history they ask different demographic questions about ankle injuries and then classify an ankle as having instability due to the athlete’s responses. However, a more specific definition of CAI may provide more valid results that support and conclude the same result. Another example of different CAI definitions is that CAI can be determined by laxity of the anterior drawer and talar tilt testing. The anterior talofibular ligament (ATFL) is the most common ligament damaged, which strongly contributes to CAI.

Muscle control has been a well-debated topic with CAI because the muscles help control the movement of the ankle, but not alone. Dynamic ankle stability uses the muscles
surrounding the ankle joint to hold the ankle in place causing stabilization to occur. If the dynamic stabilization is not helping hold the ankle in place, CAI occurs.\textsuperscript{9,16} An isometric (static) or isotonic/isokinetic (dynamic) approach\textsuperscript{16} can be used to assess ankle stability. The problem with many isometric methods is that they are subjective, meaning the measurements may vary due to the tester.\textsuperscript{16,18} Manual Muscle Testing (MMT) is a perfect example because the results depend on the resistance applied by the examiner and how hard the examiner feels the athlete resisting. When using isometric testing it is better to use dynamometers, and pressure-measuring instruments.\textsuperscript{16} The instruments will give a consistent reading, which will eliminate subjective interference.

Secondly, strength control information is reported differently, leading to differences in interpretation. Some examiners choose to use agonist-antagonist ratios, reciprocal muscle-group ratios, or ankle force-velocity relationships to assess CAI. The problem with this is determining how to compare results reported through different testing methods.\textsuperscript{1,16,17,19} There has not been an answer in how to standardize these results.

While strength is a factor contributing to CAI, kinesthesia and JPS are other factors that have also been
found to contribute to CAI.\textsuperscript{17} Kinesthesia (joint motion
detection) is the awareness of where a body part is along
with the feeling of the movement in space.\textsuperscript{13,17} To measure
kinesthesis, the equipment must be sensitive and very
accurate. The measurements will be very small so the
researcher must pay close attention to any change at all.\textsuperscript{17}
The reasoning for kinesthesia and JPS contributing to CAI
is because CAI deals with how the athlete feels his or her
ankle is feeling. Does the athlete feel that his or her
ankle is in a certain position? If not, they are having
difficulty with kinesthesia and JPS, which can make the CAI
worse. The toughest issue with measuring kinesthesia and
CAI is that the testing protocols are so different that it makes it difficult to compare different protocols.\textsuperscript{17}

Kinesthesia and JPS are also major factors in
functional activity and movement. The athlete must know
where the ankle is in relation to the body to be able to
perform functional activities correctly without injury or
reinjury. To assist an athlete having difficulty with
kinesthesia, JPS, or overall instability of the ankle, a
prophylactic ankle device may be applied.
Use of Prophylactic Ankle Devices

Prophylactic ankle devices that come in many different materials supply external ankle support. The numerous types and forms leave a lot of room for examination into how and why they effect the ankle. The effects on range of motion and proprioception have a strong effect on the ankle and how it moves, which is reflected through functional activities and performance testing.

Types of Prophylactic Ankle Devices

While there are a variety of brands of prophylactic devices on the market, each with their own strengths and weaknesses, there are two types of prophylactic ankle devices: semirigid and soft-shell braces. Johnson and Johnson introduced the first semirigid brace in 1974, but the first commercial device was introduced in 1980. The brace by Johnson and Johnson was another way of treating an ankle sprain. The first commercial prophylactic device was the Aircast Airstirrup brace. These devices are classified as semirigid because they have two shells which consist of different types of hardened plastic that fit over the medial and lateral aspects of the ankle. These shells have air cells that are positioned between the hardened
plastic and malleoli to cushion the malleoli. Velcro straps hold the shells together. This is the basic setup for any semirigid prophylactic brace. Some of the most common brands of semirigid braces are the Aircast Airstirrup, the DonJoy Ankle Ligament Protector (ALP), and the Active Ankle Training Brace.

A soft-shell prophylactic device is a device that does not contain hard plastic pieces. They can be made out of a variety of materials such as cloth (canvas) or rubber. This type of device came out in the early 1980s. Some of the most common brands of soft-shell devices are the McDavid Ankle, ASO, DonJoy lace-up Rocket Soc, and the Swede-O Universal lace-up brace. As an advantage, these devices can be bought in any sports store, but the disadvantage is that they are not fitted properly to each athlete’s foot. While the athlete or parent of an athlete can use the sizing chart on the box for the device, the brace may not fit correctly, becoming more detrimental than supportive.

Discomfort due to improper fitting of the prophylactic ankle devices is another example of how these devices are used incorrectly, causing a problem. If an athlete is not fitted for a brace correctly, the brace could further injure the athlete. If the device is not comfortable, the
athlete may chose to risk further injury and just not wear the brace. Who fits the brace can make a difference as to how the subject performs in the study, and there is a mixture of researchers who fit the braces on the subjects,\textsuperscript{3,20,21} those who have the subjects fit the braces themselves following the manufacturer’s instructions or athletic trainer’s instructions (from manufacture),\textsuperscript{6,12,22} and those who do not mention who fitted the brace.\textsuperscript{1,2,5,7,23–26}

How Prophylactic Devices Effect the Ankle

The purpose of a prophylactic ankle device is “to support the unstable ankle and to restrict inversion and eversion of the foot, without interfering with normal joint mechanics.”\textsuperscript{27(p172)} A prophylactic device is applied to the ankle to provide support, prevent injury and/or reinjury, restrict joint motion, provide mechanical support, and limit trauma.\textsuperscript{3,4,6,8,12,23,23,26–28} The most important reason for a prophylactic device is to prevent injury without inhibiting functional performance.\textsuperscript{1} The two most important concerns of prophylactic ankle devices are whether the device: 1) restricts the active range of motion (AROM), which will limit movement and is thought to prevent injury, or 2) allows full normal AROM, but restricts movement when outside the normal AROM.\textsuperscript{4,23}
Prophylactic devices can affect AROM by restricting it. If they restrict the motion significantly, then the concern of inhibiting athletic performance will be an issue. Different prophylactic devices can have an effect on gait as well. The Active Ankle and Air-Stirrup (semirigid braces) have reportedly allowed full normal AROM while restricting motion outside the normal range of motion. Conversely, the Air-Stirrup® did limit excessive eversion AROM, and also loosened (did not stay tight) throughout the exercise period. Some braces like the lace-up braces (a form of soft-shell brace) or tape change the mechanics of the foot (where pressure is exerted when weight-bearing), causing the calcaneus to have less contact with the ground. The Swede-O Universal brace (a soft-shell lace-up brace) has been found to limit normal AROM in plantarflexion and dorsiflexion. A meta-analysis by Cordova et al found through reviewing numerous studies, that ankle inversion AROM is significantly restricted at a .05 level ($P < .05$) with semirigid devices.

The Swede-O Universal lace-up brace was found to restrict AROM in speed exercises. When pushing off, plantarflexion and dorsiflexion are the motions used. Since the lace-up style brace restricts these motions, it will decrease the ROM of the push-off, therefore, the speed
of a sprint will also increase (decrease in performance).\textsuperscript{1} As well, the Swede-O Universal brace and athletic taping tend to limit dorsiflexion and plantarflexion more than the semirigid braces.\textsuperscript{1,7} Due to this limitation, an effect on vertical jump has also been reported, but not consistent throughout the literature.\textsuperscript{19,22}

Joint position sense (JPS) has been studied as a measure of proprioception. The effect of braces on JPS was not altered with taping, however, it has been found that semirigid braces assist the athlete in replicating the normal joint position, whether there is instability in the ankle or not.\textsuperscript{25,28} Neither the lace-up brace nor ankle alone could illustrate JPS with the same significance ($P < .000$ level) as semirigid brace.\textsuperscript{25} With this stated, it can be assumed that to help with proprioception and balancing in athletic events, the semirigid brace is best suited for this type of support.

External prophylactic ankle devices are being examined to determine the amount of stability they provide to the ankle.\textsuperscript{24} Roentgen stress tests\textsuperscript{24} were used to evaluate the effect of these devices on stability, and came to the conclusion that prophylactic devices could be put into three classes for specific indications. These classes are: 1) immediate post-trauma and prevention of sprains, 2)
prevention of traumatic sprain in ankles with chronic ankle instability, and 3) those for comfort and minimal compression.\textsuperscript{24} If the braces are split into categories and used for indications in that category, there will be a lower chance of decreasing functional performance.

The Effects of Ankle Devices on Functional Performance

Functional activities are an important part of athletic competition and it has been examined as to what these activities have to do with the ankle. Injured and uninjured ankles have been compared in a number of studies, but the studies have not come to a conclusion of whether ankle bracing has an effect on functional performance. Lower body function is often assessed by functional-performance activities because they incorporate muscular strength, neuromuscular coordination, and joint stability.\textsuperscript{29} After an injury or once CAI has occurred, any of these three groups could be effected and could not function normally. This is where the prophylactic bracing becomes an issue.

Commonly used functional performance tests are the shuttle run or single-leg hop.\textsuperscript{11,29} These types of testing will focus on testing balance, coordination, and joint
position control. How the brace will effect the ankle is what to be concerned with because a brace could inhibit or improve performance. External prophylactic devices are known to control motion at the subtalar joint in the frontal plane. They have been found to both obstruct normal functional performance as well as increase normal functional performance, so future research must be done using the same methods and testing equipment as previous tests to make the results easily comparable. That will make the testing more valid and the research reliable. To understand how the prophylactic devices effect the performance testing techniques, the techniques must be understood. Then the research done on how the prophylactic devices effect these techniques will make sense.

Functional Performance Testing Techniques

There are many ways to evaluate how an athlete functions in sports activities, but the most common is to evaluate functional activities. This is the best way to find out what the athlete needs more work on, as well as learning what their stronger aspects are. The most common functional performance tests can be categorized into sprint testing, agility testing, and vertical jump testing.
Sprint Testing. One of the most common movements in sport is running or sprinting.\textsuperscript{19} As a rule, an athlete will choose not to wear a prophylactic ankle device if they know it may inhibit their athletic performance. That is why testing functional activities used in sports competition is important. When doing functional testing, different types of braces should be tested to examine the effectiveness of each brace in the functional test being examined. Measuring a sprint with a distance anywhere from 20 feet to 60 yards is what sprint testing has involved.\textsuperscript{2-4,19,20,22,27}

This is where the controversy arises; some researchers have found no change in speed due to the prophylactic bracing,\textsuperscript{2-4} while others have found a decrease in sprint performance.\textsuperscript{1} Since the testing is done at different distances, it is hard to compare the results. One way to resolve this issue is to determine the effect size, which “is a standardized measure of change associated with treatment.”\textsuperscript{7} This takes an average of the different experimental and control groups, and then divides the average by the standard deviation of the groups.\textsuperscript{7} Another way to resolve this issue would be to have a testing protocol followed by everyone doing a specific type of test. If the 40-yard dash were chosen, then everyone testing prophylactic ankle devices or ankle stability in
speed or velocity should use this functional activity instead of a 20 foot to 60-yard sprint difference.

**Agility Testing.** There are many functional performance-testing protocols for agility testing which is why it is so difficult to compare studies on agility testing. The most common testing protocols are the T-test, SEMO agility test, the Shuttle Run, Figure-of-Eight Run, and the Four-Point Run.\(^2,4,16,27\) The purpose of agility activities is to test and examine quick directional changes, multidirectional movements, sprinting, and acceleration and deceleration.\(^{19}\)

The problem with such a variety of tests is that they measure different aspects of agility. When testing to see if a prophylactic device is effective, having lateral movements as well as different length sprints is very important because inversion/eversion sprains are the most common type of injury in sports today.\(^1,2,5,6\) The 18.28m (20-yd) Shuttle Run is a commonly used performance test, but it is a test used in physical education classes as well, requiring the subject to sprint forward and to each side.\(^2\) It does not require that the athlete sprints backwards at all, which leaves out an integral part of many athletic activities.
Vertical Jump Testing. Jumping is a very common part of athletic competition. A number of sports place major emphasis on jumping, such as volleyball, basketball, and many track events (triple jump, long jump, hurdles), while other sports such as football, baseball, softball, and soccer all incorporate some jumping into the game as well.

Vertical jump testing is the easiest way to test power. This test is not difficult to administer, but can be difficult in comparison. Most studies do not state exactly how the jump was performed. The procedure is stated as in how the instrumentation was set up whether they used the Just Jump System, the Vertex, or jumping next to the wall with chalk on the ends of the subjects fingers.²⁻⁴,¹⁹,²²,²⁷

The literature has shown that ankle bracing has been used and tested for in different functional performance activities. The problem is that a comparison of the studies is difficult due to the number of different tests used in each of the three functional activities, leading to inconsistent results.
Ankle injuries are very common in athletics, and a variety of prophylactic devices can be used to provide stability, support, and to prevent injury. Different types of prophylactic ankle devices provide more or less support or stability depending on the motion. The two common types of braces are semirigid and soft-shell. The biggest issue with prophylactic bracing is that the braces can be bought over the counter by athletes and as a rule, and are not fitted correctly. That is where an athletic trainer comes in handy to help the athlete to correctly fit the brace.

The most important reason for a prophylactic device is to prevent injury without hindering the functional performance of the athlete. It is widely debated whether the prophylactic devices restrict active range of motion (AROM).\textsuperscript{1,2,4,7,12,23} Joint position sense (JPS), a measure of proprioception can also be effected with bracing, either by helping with stability or causing the ankle to be unstable.\textsuperscript{28}

The reason the ankle is so commonly injured is due to the complexity of the numerous articulations in the ankle complex. The tibiofibular, talocrural, and subtalar joints are the places of articulation in the ankle.\textsuperscript{13} Movements
like pronation and supination are created by movements of
the foot and ankle combined at the same time.\textsuperscript{14} Factors
that contribute to the instability of the ankle are
kinesthesia and JPS, muscle control and strength control.

Functional activities such as the 40-yard Dash, the T-
test for Agility, and the Vertical Jump Test are good
measures of how a brace can effect a functional activity.
These separate tests have been found to be valid and
reliable tests of speed (velocity), quickness in change of
direction, and the height of a jump respectively. These
tests are great ways to evaluate any type of prophylactic
bracing whether it be for the ankle or knee. Although
there is much conflict in whether prophylactic ankle braces
positively or negatively effect the ankle and functional
activity, the literature agrees in most cases there is some
type of effect.
APPENDIX B

The Problem
Statement of the Problem

Studies on how prophylactic ankle devices (ankle bracing) effect performance have come to an inconsistent conclusion as to whether performance is inhibited by the bracing. The purpose of this study is to examine whether prophylactic ankle devices effect functional performance. If inhibition of performance occurs while wearing a prophylactic brace, the athlete will not want to wear the brace. To test these braces, the subject will perform three functional tests: 40-yard Dash, T-test for Agility, and the Vertical Jump Test with two different bracing conditions and the no brace condition.

Definition of Terms

The following terms will be operationally defined for better understanding of the literature:

1) Agility - the ability to decelerate, stabilize, accelerate and change direction without the loss of proper posture, speed, strength, balance, or body control. This requires optimum neuromuscular control because the athlete is working to keep their center of gravity over their changing base of support in any direction.30
2) Functional performance activities - these are activities that use explosive, quick movements used in athletic competition.

3) Instability - the feeling of giving way or of the ankle feeling loose when walking. This may be caused by repeated ankle injury.

4) Joint Position Sense (JPS) - JPS has been studied as a measure of proprioception, and it is the ability for the body to be aware of where the joint is in relation to the rest of the body.

5) Kinesthesia - how the body responds to movement of the joint and the position of the joint in space.

6) Prophylactic ankle device - a device applied to the ankle to provide stability, support, and help prevent injuries to the ankle.

7) Semirigid braces - braces are classified as semirigid if they have two shells consisting of various types of hardened plastic that covers the medial and lateral aspects of the ankle. The braces often have air cells cushioning the malleoli. Some examples are the Aircast Airstirrup, DonJoy Ankle Ligament Protector, and the Active Ankle Training Brace.

8) Soft-shell braces - braces that have no hardened plastic shells and can be made out of various cloth or
rubber materials. Some examples are the McDavid Ankle, ASO, DonJoy lace-up Rocket Soc, and the Swede-O Universal lace-up brace.

9) T-test: the T-test measures quick directional changes and four-directional agility. It is an agility exercise because it involves multidirectional and quick movements involving acceleration and deceleration.¹⁴

Basic Assumptions

The basic assumptions for this study are as follows:

1) All subjects will be honest in reporting no previous lower extremity injury within the past six months, as well as honest in reporting previous experience with bracing.

2) All subjects will give their best effort during the functional performance testing.

3) All subjects will participate in this study without coercion from the coach.

4) The 40-yard Dash is a valid and reliable \( r = 0.53 \) tool to measure maximum speed.³⁰

5) The T-test for Agility is a valid and reliable \( r = 0.98 \) tool to measure maximum agility.³⁰
6) The Vertical Jump Test is a valid and reliable ($r = 0.71$ to $0.91$) tool to measure maximum vertical jump height.\textsuperscript{31}

7) The Speed Trap II Timer\textsuperscript{30} is a valid and reliable tool to measure speed and quickness.

8) The Just Jump System\textsuperscript{30} is a valid and reliable tool to measure vertical jump height.

**Limitations of the Study**

The limitations for this study are as follows:

1) Testing will be done in a laboratory, which means the results may not apply to the different sports due to different surfaces used in that sport.

2) Although two types of braces will be used, the results will only be generalized for soft-shell braces. No semirigid braces will be tested in this study.

3) External validity may be of concern due to the limited population of NCAA Divisions II and III female athletes from California University of Pennsylvania and Norwich University.

**Significance of the Study**

Ankle injuries are among the most common injuries in athletics today.\textsuperscript{1-12} Lack of stability, support, and injury
prevention have brought about the need for prophylactic ankle devices. Athletes need some type of support but will not wear a prophylactic device if there is a chance it can inhibit functional athletic performance. Previous research has been inconsistent in stating whether prophylactic devices inhibit functional performance. Although many studies have looked at this issue, this study is unique in that current research has not been done to help validate the past findings. This study will attempt to test the ability of an athlete to perform the 40-yard dash, T-test for agility, and a vertical jump test with the Swede-O Lace Up Ankle Lok® brace, the Ankle Stabilizing Orthosis® brace (ASO), and no brace to determine whether the brace inhibits performance. Since athletic trainers today offer different methods of support through ankle taping and bracing, it is important to know if bracing inhibits performance. If so, athletic trainers may reconsider forms of treatment and support. The results of this study are aiming to support previous studies on the effectiveness of prophylactic ankle devices. The results could assist certified athletic trainers in determining which braces are better for different functional activities and which braces have no detrimental effects.
APPENDIX C

Additional Methods
APPENDIX C1

Informed Consent
Informed-Consent Form

1. Sonia Masse, who is a Graduate-Assistant Athletic Training Student, has requested my participation in a research study at California University of Pennsylvania. The title of the research is: The effects of two ankle braces on sprint speed, agility, and vertical jump height in healthy female collegiate athletes.

2. "I have been informed that the purpose of the research is to determine whether either the Swede-O or ASO prophylactic ankle devices decrease an athlete’s ability to perform the sport to her full potential. I understand that I have been asked to participate, along with 29 other participants because I have had no previous injury to my ankles in the past six months, and because I am currently a female varsity athlete at California University of Pennsylvania."

3. "My participation will involve testing my speed in the 40 Yard Sprint Test and agility in the T-Test, and my vertical jump height recorded with the Just Jump System™. The testing will be done three times; with no brace, the Swede-O brace, and the ASO brace. My participation in this study will consist of an orientation meeting, and three meetings for testing."

4. "I understand there are foreseeable risks or discomforts to me if I agree to participate in the study. The possible risks and/or discomforts include possible ankle injury or soreness due to activity. To minimize these risks and discomforts the researcher will have me perform a proper warm-up before participating in functional testing. The researcher will also provide any treatment or stretching to minimize any muscle soreness due to testing. The muscle soreness that may occur due to testing is no more than any other workout."

5. "I understand that, in case of injury, I can expect to receive treatment or care in Hamer Hall’s Athletic Training Facility. This treatment will be provided by the researcher, Sonia Masse, under the supervision of another Certified Athletic Trainer, either of which whom can administer emergency and rehabilitative care. Additional services needed for prolonged care past thee days will be
referred to the attending physician at the Downey Garofola Health Services located on campus.”

6. "There are no feasible alternative procedures available for this study."

7. "I understand that the possible benefits of my participation in the research are to provide more current research to add to existing research, which will contribute to which braces will be most effective in preventing ankle injury."

8. “I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Sonia Masse, will maintain all documents in a secure location (filing cabinet in the researcher’s apartment), which only the student researcher and research advisor can access. Subjects will be assigned a number and will be referred to only by those numbers during the testing.”

9. "I have been informed that I will not be compensated for my participation."

10. “I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Sonia Masse, 947 Cross Street, Apt. #1, California, PA 15419, 724-825-8074, mas0279@cup.edu, or by Dr. Robert Kane (research advisor), Hamer Hall, 250 University Ave, California, PA 15419, 724-938-4562, Kane@cup.edu.”

11. “I understand that written responses may be used in quotations for publication but my identity will remain anonymous.”

12. “I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be provided to me.”

Subject’s signature: _______________________ Date: _______
Witness signature: _________________________ Date: ________

13. “I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.”

14. “I have provided the subject/participant a copy of this signed consent document.”

Researcher’s signature: ________________________________
Date: _____________

Approved by the California University of Pennsylvania IRB.
APPENDIX C2

Demographic Information Sheet
Subject #: ______

Demographic Information Sheet

1. Sport: ______
2. Position: ______
3. Age: ______
4. Height: ______
5. Weight: ______

6. Do you wear custom orthotics for the foot or ankle?
   YES           NO

7. Have you ever had any surgery to the lower extremity?
   YES           NO

   If yes, to what part of the lower extremity?
   HIP           KNEE           ANKLE

8. Have you ever worn any type of ankle brace in high school or college?
   YES           NO
Part II of Demographic Information Sheet

Now that you have completed this study, please answer the following questions based on the braces used in the study.

9. The ankle braces in this study had an effect on functional performance in your sprint speed.
   STRONGLY AGREE        AGREE        DISAGREE        STRONGLY DISAGREE

10. The ankle braces in this study had an effect on the functional performance in your agility time.
    STRONGLY AGREE        AGREE        DISAGREE        STRONGLY DISAGREE

11. The ankle braces in this study had an effect on the functional performance in your vertical jump height.
    STRONGLY AGREE        AGREE        DISAGREE        STRONGLY DISAGREE

12. The ankle braces in this study are supportive.
    STRONGLY AGREE        AGREE        DISAGREE        STRONGLY DISAGREE

13. The ankle braces in this study prevent injury.
    STRONGLY AGREE        AGREE        DISAGREE        STRONGLY DISAGREE
APPENDIX C3

Ankle Braces
Swede-O Ankle Lok® Ankle Brace

http://www.ankleshop.com/anklelok1.htm
The ASO Ankle Stabilizing Orthosis® Ankle Brace

http://www.ankleshop.com/aso.htm
APPENDIX C4

Functional Testing and Equipment
T-test for Agility$^{30}$
Speed Trap II Timer™

http://www.power-systems.com/nav/closeup.aspx?c=19&g=1354#
Just Jump System™

http://www.power-systems.com/nav/closeup.aspx?c=5&g=1384#
APPENDIX C5

Institutional Review Board
California University of Pennsylvania

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title: The Effects Of Two Ankle Braces On Sprint Speed, Agility, And Vertical Jump Height In Healthy Female Collegiate Athletes.

Researchers/Project Director: Sonia Jean Masse

Phone #: (724) 874-8074  E-mail Address: mas9279@eps.edu

Faculty Sponsor (if required): Dr. Robert Kane

Department: Health Science and Sport Studies

Project Dates: January 2006 to May 2006

Sponsoring Agent (if applicable):

Project to be Conducted at: California University of Pennsylvania

Project Purpose: ☑️ Thesis  ☐ Research  ☐ Class Project  ☐ Other

Keep a copy of this form for your records.

Required IRB Training

The training requirement can be satisfied by completing the online training session at http://cere.mci.nih.gov/. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:

Previous Project Title: ____________________________

Date of Previous IRB Protocol: ____________________

Draft, April 7, 2005
Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(es) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.

   Prophylactic ankle devices have become important for stability, support, and injury prevention, and this study will examine how braces prophylactic ankle devices effect functional performance. The subjects for this study will be volunteer female Division II Collegiate Athletes from California University of Pennsylvania. This subject will participate in all three functional tests with all three conditions, making it a within-subject design. The functional tests being used are the 40-yard Dash, the T-Test for Agility, and the Vertical Jump Test. The researcher hypothesized that sprint speed will be slower for subjects wearing a prophylactic brace than no brace, agility time for a subject wearing a prophylactic brace compared to no brace will not change, and that vertical jump height will be lower for athletes wearing a prophylactic brace compared to none. The information will be gathered for the 40-yard Dash and T-Test for Agility by the Speed Trap II Timer™ measured in seconds, and for the Vertical Jump Testing by the Just Jump System™ measured in inches.

2. Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.

   a. How will you ensure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.

      The researcher will minimize risks by supervising subjects in a proper warm-up before functional testing. The researcher will also provide any treatment or stretching to balance out any muscle soreness due to testing. The testing involves no more than regular physical exertion and should subside within two to three days.

   b. How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.

      The subjects will be based on a sample of convenience of female Division II athletes at California University of Pennsylvania. Subjects will be volunteers with no coercion or influence from the coaching staff, and subjects who have had a history of ankle injury in the past six-months will be excluded from the study. Subjects will then be randomly assigned to functional testing (treatment) groups, as well as the order the functional tests will be performed.

   c. How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.

      Informed consent (Appendix C1) will be obtained from each participant at an orientation meeting explaining what the study will entail. Each participant will be assigned a number and will use the number as a replacement for the name to ensure privacy. The informed consent form will be kept on file, and a copy will be given to each participant.

   d. Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.

Draft, April 7, 2005
Data collected will be recorded on the Data Collection Sheets found in Appendix C5. The researcher will administer all testing sessions to ensure safety of all subjects and privacy of response. All forms containing subject identity will remain in a secure location in which researcher Sonia Mason and research advisor Robert Kane will be the only ones with access to information. The results of this study may be published, but subjects' identity will not be revealed.

3. Check the appropriate box(es) that describe the subjects you plan to use.

- Adult volunteers
- CAL University Students
- Other Students
- Prisoners
- Pregnant Women
- Physically Handicapped People
- Mentally Disabled People
- Economically Disadvantaged People
- Educationally Disadvantaged People
- Fetuses or fetal material
- Children Under 18
- Neonates

4. Is remuneration involved in your project?  
- Yes or  
- No. If yes, Explain here.

5. Is this project part of a grant?  
- Yes or  
- No. If yes, provide the following information:
  
  Title of the Grant Proposal: The effects of two ankle braces on sprint speed, agility, and vertical jump height in healthy collegiate female athletes.
  
  Name of the Funding Agency: Jesse B. Guttman Student Research Grant.
  
  Dates of the Project Period: January 2006 through May 2006.

6. Does your project involve the debriefing of those who participated?  
- Yes or  
- No. If yes, explain the debriefing process here.

   The abstract to my research will be posted electronically through the library’s website here at California University for any participant to access.

7. If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix ___ in the Policies and Procedures Manual.

Draft, April 7, 2005
Project Director's Certification
Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature ____________________________ Department Chairperson's Signature ____________________________

Student or Class Research

Student Researcher's Signature ____________________________

Supervising Faculty Member’s Signature ____________________________ Department Chairperson’s Signature ____________________________

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved   ☐ Disapproved

Chairperson, Institutional Review Board ____________________________ Date 12/20/2005

Draft, April 7, 2005
APPENDIX C6

Data Collection Forms
## Data Collection

### Sprint Speed

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## Data Collection

### Agility

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## Data Collection

### Vertical Jump Height

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<th>ASO Ankle Brace</th>
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REFERENCES


ABSTRACT

Title: THE EFFECTS OF TWO ANKLE BRACES ON SPRINT SPEED, AGILITY, AND VERTICAL JUMP HEIGHT IN HEALTHY FEMALE COLLEGIATE ATHLETES

Researcher: Sonia J. Masse

Adviser: Dr. Robert Kane

Date: May 2006

Research Type: Master’s Thesis

Purpose: The purpose of this study was to investigate the effects of the Swede-O Ankle Lok® and the Ankle Stabilizing Orthosis® ankle braces on sprint speed, agility, and vertical jump height in healthy NCAA Division II and III female athletes.

Problem: Studies on how prophylactic ankle devices (ankle bracing) effect performance have come to an inconsistent conclusion as to whether performance is inhibited by the bracing.

Method: Twenty female NCAA Divisions II and III athletes from California University of Pennsylvania and Norwich University in Northfield, Vermont volunteered to participate in this study. Subjects were required to participate in three days of testing in which they performed a 40-yard dash, T-test for agility, and a vertical jump for each condition (Swede-O Ankle Lok® brace, Ankle Stabilizing Orthosis® (ASO) brace (soft-shell braces), and no brace). The order the braces were worn was randomly selected and each subject served as their own control when wearing no brace.

Findings: No significant difference was found for athletes performing functional activities when wearing a brace or no brace. Eight of the twenty subjects have previous bracing experience and no significant effect was found between the group with previous
experience bracing and the group without previous experience. It was also found that the majority of subjects felt bracing had an effect on performance, even though the bracing did not affect sprint speed, agility time, and vertical jump height.

**Conclusion:** The Swede-O Ankle Lok® and Ankle Stabilizing Orthosis® are both soft-shell braces. Since the braces did not inhibit functional performance, braces can be worn for support without the concern of influencing athletic performance. The majority of the subjects felt the bracing has some effect on performance even though it did not. The subjects in this study also felt the bracing was supportive and would prevent injury. This study supports the literature stating bracing does not inhibit functional performance and that bracing is a good idea for support and prevention. The fact that only female athletes were tested is also important because few studies have focused on collegiate female athletes alone. Performance in each functional test was consistent with or without the bracing condition.