THE EFFECTS OF FATIGUE AND GENDER ON THE STAR EXCURSION BALANCE TEST IN HIGH SCHOOL ATHLETES

by
Megan O'Neill

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Megan O'Neill

Approved: ____
Thomas W. Kaminski, Ph.D.
Professor in charge of thesis on behalf of the Advisory Committee

Approved: ____
Todd D. Royer, Ph.D.
Interim Chairperson of the Department of Kinesiology and Applied Physiology

Approved: ____
Kathleen S. Matt, Ph.D.
Dean of the College of Health Sciences

Approved: ____
Charles G. Riordan, Ph.D.
Vice Provost for Graduate and Professional Education

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ABSTRACT

Context: More than 7 million students are involved in high school sports annually in the United States. Disturbances in postures as result of fatigue have been postulated to effect male and female interscholastic athletes differently. It is important that this population be studied, and the mechanism by which these injuries are produced be determined. **Objective**: The purpose of this study was to determine the effects gender and fatigue have on postural control in a group of healthy high school athletes as measured by modified version of the Star Excursion Balance Test (SEBT). **Design:** Within groups, pre-test/post-test study. **Setting:** A climate controlled, research center. **Participants:** A total of 30 healthy varsity high school athletes, 15 male (age= 17.1±1yrs; height=175.8cm±9.2; mass=70.1±8.5kg) and 15 female (age= 16.4±1; height=166cm±8.2; mass=60.6±7kg) participated in this study. **Interventions:** The subject's dynamic postural control was tested using the modified SEBT before and after completing a functional fatigue protocol. **Main Outcome Measures:** The normalized component reach directions including anterior (ANT), posteromedial (PM), and posterolateral (PL) and the composite reach distance scores for both the right and left side were used as dependant measures for analysis in this study. A univariate, repeated-measures analysis of variance (ANOVA) was used to analyze data in this study. There were two groups in the analyses: male and female. An alpha level of .05 was used to determine significance. **Results:** There was a significant group by time interaction (Pillai's trace $F_{1,30} = 4.339$; $P = .047$) for the left composite reach score. Females demonstrated a significant decline in composite reach scores (88.9 ± 2.0 to 86.7 ± 2.03) compared to males (91.4 ± 2.0 to 92.5 ± 2.027). The right composite reach score also demonstrated a similar trend between males/females post fatigue **Conclusions:** Differences were observed between genders during the performance of the SEBT, with females demonstrating more of a decline in reach distances compared to males.

Keywords: dynamic postural control, SEBT, functional fatigue protocol

Chapter 1

THE EFFECTS OF FATIGUE AND GENDER ON THE STAR EXCURSION BALANCE TEST ON HIGH SCHOOL ATHLETES

1.1 Introduction

More than 7 million students are involved in high school sports annually in the United States.[1] Along with the increasing number of adolescent participants comes an estimated 2.5 million sports-related emergency room visits per year.[1] High school athletes alone were responsible for more than 1.4 million injuries during the 2005–2006 school year.[2] With so many young people active and sustaining injuries in high school athletics, it is important that research addresses this population and identifies the mechanisms by which these injuries are produced.

Success in high school athletics involves several components of fitness including strength, endurance, coordination, and balance. Balance is generally considered an important component of athletic activities and is required for sport.[3] Balance, or postural control, can be described as static or dynamic. Static postural control is an attempt to maintain a base of support with minimal movement of the body segments and maintaining one's center of mass.[4] Dynamic postural control involves controlling one's center of mass while the base of support is moving.[5] The inability to maintain postural control has been associated with a general risk for injury in sport.[3] Poor postural control abilities have also been linked with increased risk of injuries in both male and female adolescent athletes.[6, 7] The ability of an individual to maintain balance depends on proprioceptive input from musculotendinous and capsuloligamentous mechanoreceptors in conjunction with visual and vestibular input to the central nervous system.[8] This input is used in both feedback and feed-forward loops to provide and appropriate neuromuscular response.[8, 9] Alterations in any of these inputs would likely alter balance and has been shown to be correlated with risk of injury.[10] Postural control has been measured statically using postural sway, and the Balance Error Scoring System (BESS), as well as and dynamically using the time to stabilization method, which is a measure of neuromuscular control that uses force plate measures to evaluate dynamic postural stability during jump landing[11] and the Star Excursion Balance Test (SEBT).

There are numerous ways in which a person sustains an injury during athletic activity and fatigue may be an important component in the cause of these injuries. Fatigue has been implicated as a causative factor in sport-related injuries, with strong epidemiological evidence that contends that more than half of all injuries occur late in competitions or practice.[12, 13] It is also important to note that 58% of these injuries result from non-contact mechanisms.[12] Previous literature has reported that fatigue is responsible for: decreases in force production and neural drive; altered peripheral feedback and diminished postural stability; changes in reflexive function and muscle contractile properties; and modifications to other neuromuscular control mechanisms.[14] While the exact relationship between fatigue and injury remains unproven, fatigue has repeatedly been hypothesized to cause alterations in neuromuscular and biomechanical properties, thus increasing the risk for injury.[10] Multiple processes within the musculoskeletal and nervous systems contribute to muscle fatigue, many of which begin at the onset of voluntary contraction.[14, 15] Fatigue is believed to increase the threshold of muscle-spindle discharge, disrupting afferent feedback, and subsequently altering afferent information concerning joint awareness entering the central nervous system.[16] The afferent information is a critical portion of the feedback loops that help create and maintain postural control.[5] The study and analysis of muscle fatigue is often divided into two types of fatigue: peripheral and central fatigue. Peripheral fatigue refers to exercise-induced processes that lead to a reduction in force production and that occur at or distal to the neuromuscular junction.[17] Central fatigue refers to more proximal processes and can be defined as a progressive exercise-induced failure of voluntary activation of the muscle.[14] Central fatigue can be demonstrated by an increase in the increment in force evoked by nerve stimulation during a maximal voluntary effort.[14, 15] Any of these factors could potentially increase the risk for injury, yet previous studies predicting fatigue-related effects may have used insufficient methods to achieve fatigue in the subjects.[18] Several previous investigations have employed controlled interventions to achieve a fatigued state, including isometric and isokinetic contractions.[5, 16, 19-23] It is possible that these results are not able to be directly related to the fatigue that results from a sporting competition or practice. Recent studies have shown that fatigue and decision making, both key components of sports participation, have contributed to an increased ACL injury risk due to altered knee joint biomechanics.[24, 25] Multifaceted tasks such as dynamic sports maneuvers require explicit force production and control at both the peripheral and central levels. It seems plausible to assume that fatigue-induced ACL injury risk stems from both peripheral and central fatiguing mechanisms.[26] Thus, it is reasonable to test subjects in this environment. Recently a functional fatigue protocol that replicates activities commonly associated with athletic competition has been proposed.[18]

It has been reported that female athletes are 4 to 6 times more likely to sustain a major knee injury then males.[24] Epidemiological evidence shows that among high school sports, football had the highest severe injury rate, followed by wrestling, female' basketball, and female' soccer.[27] However, when injury rates were compared among similar high school sports (soccer, basketball, and baseball/softball), female sustained a higher severe injury rate than male.[1, 28] The ankle/foot was the most commonly injured body part for both genders followed by the knee. In relation to the knee joint, major and minor rates were higher in females as compared to males. Males, however, showed higher rates of fractures and general trauma injuries for baseball, basketball, and, soccer than their female counterparts.[28] With the disparity in severe injury rates among high school athletes, more investigation needs to be done to identify potential mechanisms for these injuries. Therefore, the purpose of this study was to determine the effects gender and fatigue have on postural control in a group of healthy high school athletes as measured by modified version of the Star Excursion Balance Test (SEBT).

1.2 Research and Design Methods

1.2.1 Participants

A total of 30 healthy varsity high school athletes, 15 males (age= 17.1±1yrs; height=175.8cm±9.2; mass=70.1±8.5kg) and 15 females (age= 16.4±1; height=166cm±8.2; mass=60.6±7kg) participated in this study. Female subjects were recruited from a variety of interscholastic sports including basketball (n= 5), soccer (n=4), field hockey (n=3) softball (n=2), and lacrosse (n=1). Male sports included basketball (n=5), soccer (n=4), wrestling (n=3), lacrosse (n=2), football (n=1), and baseball (n=1). Eleven of the athletes were on 2 or more varsity teams throughout the school year; however, they are listed for the sport in which they were participating at the time the test was taken. Varsity athletes were sampled in order to more closely match the athletes' skill levels and stages of physical and mental development. All participants were cleared for participation as verified by their approval via the Delaware Interscholastic Activities Association (DIAA) physical examination form. Subjects were excluded from this study if they had: a history of ankle instability, sustained an ankle sprain within the previous year, had a history of stress fractures or any other significant lower extremity injury, or a history of balance disorders or a recent injury that affects balance. Prior to testing, all participants completed and signed the approved consent form (UDIRB# HS-09-650). Those participants who were minors had additional parental consent, as well as informed assent.

1.2.2 Instrumentation

A modified version of the SEBT (Y-Balance Test Kit, Perform Better, Cranston, RI) developed by Plisky et al. was used to quantify balance in this study.[29] This is a dynamic test that requires strength, flexibility, and proprioception in order to maintain a single leg stance while reaching as far as possible with the other leg.[30] The Y Balance Test™ (YBT) consists of a stance platform to which three pieces of pipe are attached in the anterior (ANT), posteromedial (PM), and posterolateral (PL) reach directions. The posterior pipes are positioned 135 degrees from the anterior pipe with 45 degrees between posterior pipes. Each pipe is marked in 5 mm increments for measurement.[29] The subject places one foot on the center stationary platform and attempts to push a moveable platform as far as possible along the pipes of the designated reach direction while maintaining postural control. The reach distance was measured as the distance in centimeters that the subject was able to push the moveable platform. The reliability for this device has been shown to be very high.[29]

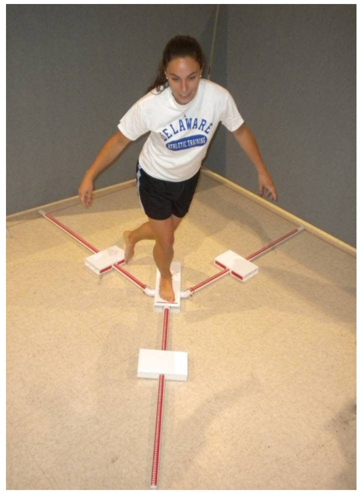

Figure 1. A demonstration of posterolateral reach direction on the Y Balance Test™

1.2.3 Testing Protocol

The participants watched an instructional video for the YBT demonstrating the test and testing procedure. The subjects practiced a minimum of six trials per reach direction on each foot to familiarize themselves with testing procedures. All trials were conducted with the subjects barefoot. The test consisted of three reaches in each direction: ANT, ML, and PL for both the right and left foot. As per the YBT instructions, the stance foot was maintained in the center on the stance platform with toes as close to the red line as possible without going over the line. The subject then pushed the moveable platform with the other foot as far as possible along the pipes of the designated reach direction while maintaining postural control (Figure 1). The reach distance was measured as the distance in centimeters that the subject was able to push the moveable platform. The subjects performed three trials in each direction, starting with the anterior reach with the right foot on the stance plate followed by the anterior reach with the left foot on the stance plate. This was followed by right and left reaches in the posteromedial and posterolateral direction respectively. This concluded the pretest measurements on the YBT. At the conclusion of the YBT trials, there was a brief warm up consisting of five minutes on a stationary bike followed by four minutes of lower body stretching prior to beginning the Functional Fatigue Protocol (FFP).18 The FFP consists of multiple activities done in a 5 meter square. It is as follows: 5 meter sprint, followed by 5 meters of side shuffling, 5 meters back peddling, another 5 meter sprint followed by thirty side to side hops over a wooden 2 x 4, and ending with three plyometric box jumps of ascending height (Figure 2). The height of the plyometric boxes are 30.48 cm, 45.72 cm, and 60.96 cm (12, 18, 24 inches) respectively. After completing the full circuit, the participant was asked to rate their perceived level of exertion based upon the Borg Scale.31 The Borg Scale is a 6 to 20 point scale rating of perceived exertion, with 20 being maximum exertion, often used to gauge an athlete's level of intensity in training and competition.31 To determine a baseline score participants were timed from the start of the first sprint until they completed the box jumps using an automatic timing system (Polaris Electronic Timer, Farmtek, Wylie, TX). The participants then repeated the protocol, with a twenty second rest between repetitions of the FFP, until one of the following fatigue criteria was achieved: baseline time increased by 50 percent; a 35 percent increase in time as well as ten consecutive maximum exertion scores; a failure on any of the aspects of the protocol; or until the participant decided he or she was unable to complete further repetitions. At this point subjects were considered fatigued as per the guidelines established by Douex et al.[18] Upon completion of the FFP, subjects were immediately retested on the YBT using the same methods as the pretest measurements.

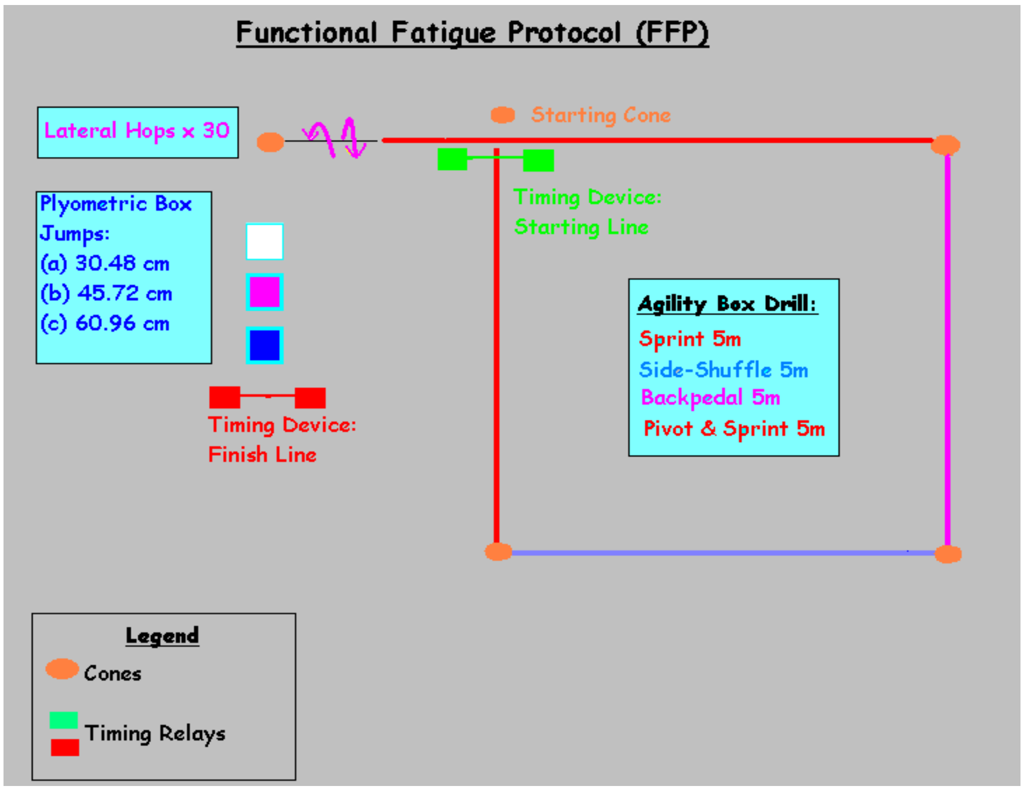

Figure 2. Functional Fatigue Protocol

1.2.4 Data Analysis

A univariate, repeated-measures analysis of variance (ANOVA) was used to analyze data in this study. A separate repeated-measures ANOVA was completed for each dependent variable. The normalized component reach directions including ANT, PM, and PL and the composite reach distance scores for both the right and left side were used as dependant measures for analysis in this study. There were two groups in the analyses: male and female. To express reach distance as a percentage of limb length, the normalized value was calculated as reach distance divided by limb length then multiplied by 100. Composite reach distance was calculated as the sum of the three reach directions divided by 3 times limb length, and multiplied by 100.[29]

1.3 Results

1.3.1 Composite Reach Scores

There was a significant group by time interaction for the Left Composite Score (Figure 3) (Pillai's trace $F_{1,30} = 4.339$; $P = .047$). Pair-wise comparisons revealed differences between males and females post-fatigue whereas the female demonstrated a significant decline in composite reach scores (88.9 ± 2.04 to 86.72 ± 2.03) compared to males (91.39 ± 2.04 to 92.48 ± 2.03) who improved. Although the analysis involving the right composite score did not demonstrate a significant group by time interaction (Pillai's trace $F_{1,30} = 3.7$; $P = .065$), a similar trend involving male (90.04±2.33 to 91.0±2.31) versus female post-fatigue (87.43±2.33 to 84.81±2.31) emerged and reinforced the deficit in composite reach scores post fatigue in the females(Figure 4).

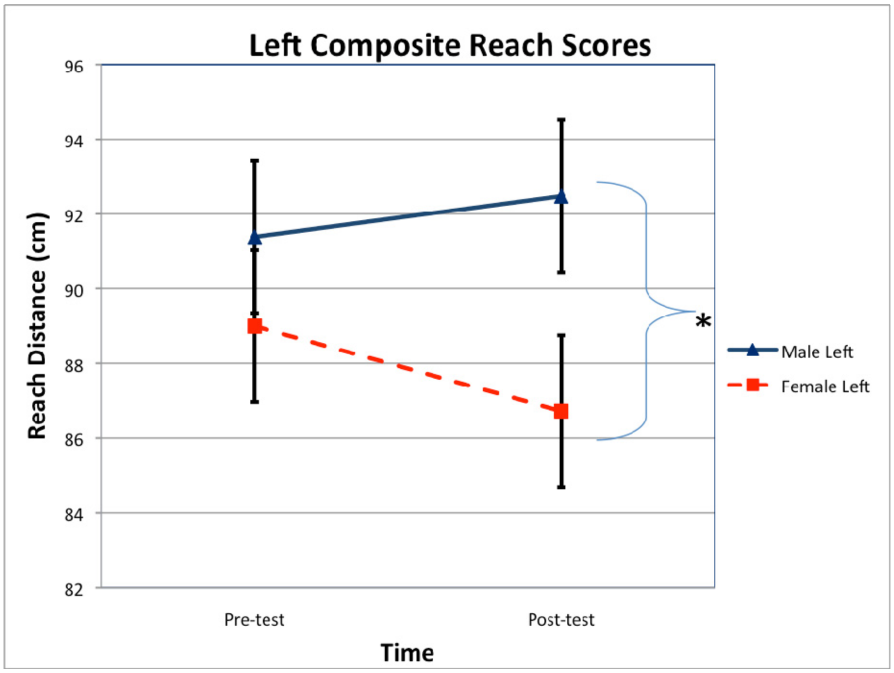

Figure 3. **A significant group by time interaction (*) was found in the Left Composite reach scores**

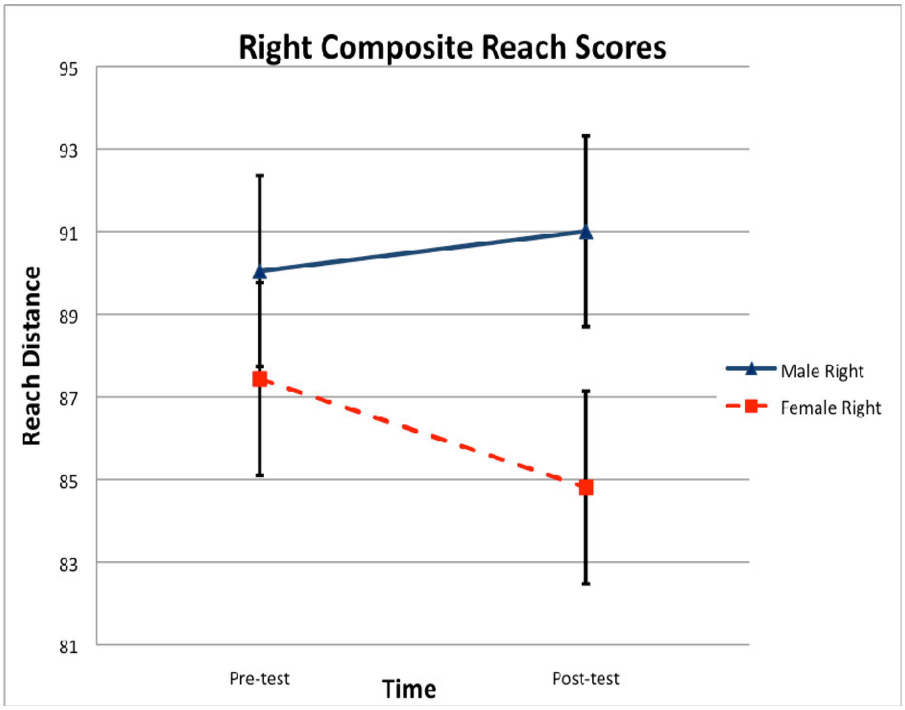

Figure 4. Right Composite reach scores

1.3.2 Individual Reach Scores

Subsequently there were significant group main effects for gender involving the individual reach scores for both right PM and left PM reaches (Figure 5). In both cases the male reach scores were greater than female. However, it is important to remember that these scores are pooled values combining both pre and post-fatigue reach distances (male 112.9± 4.2 versus female 97.7±4.2). There were however no significant differences in either right (p=.140) or left (p=.164) PL reach scores between the groups pre to post test (Figure 6). Additionally, there were no significant differences in right (p=.089) or left (p=.061) ANT reach scores between the groups pre to post test (Figure 7). However, as noted in figures 5-7 it is evident that a trend towards significance is occurring whereas the females tend to demonstrate decreased reach distances post-fatigue when compared when compared to their male counterparts.

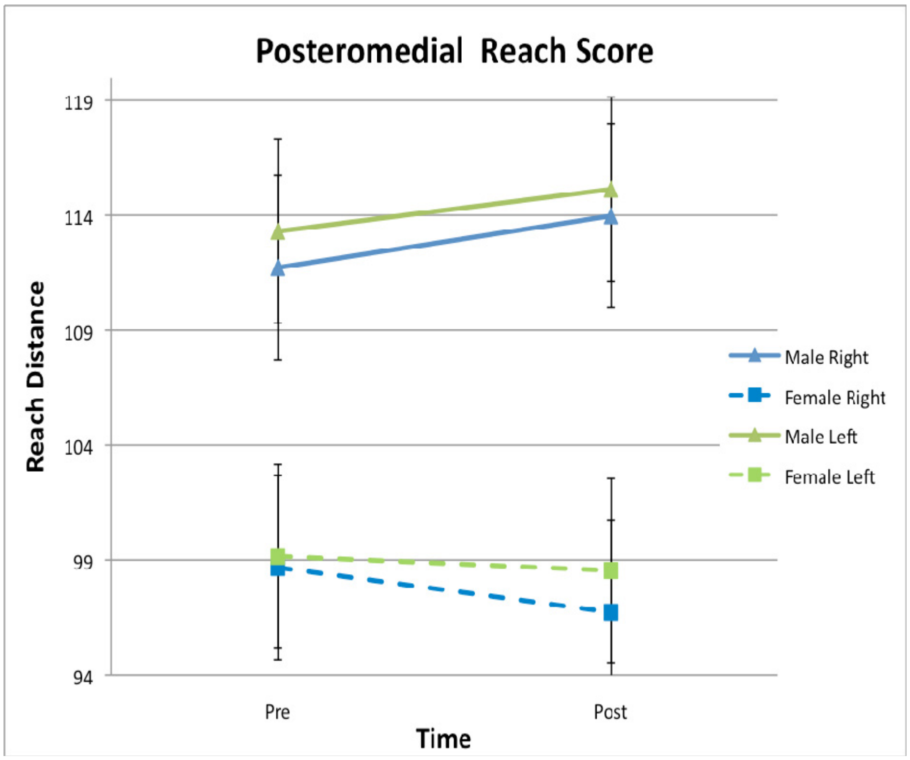

Figure 5. **Right and left posteromedial reach scores**

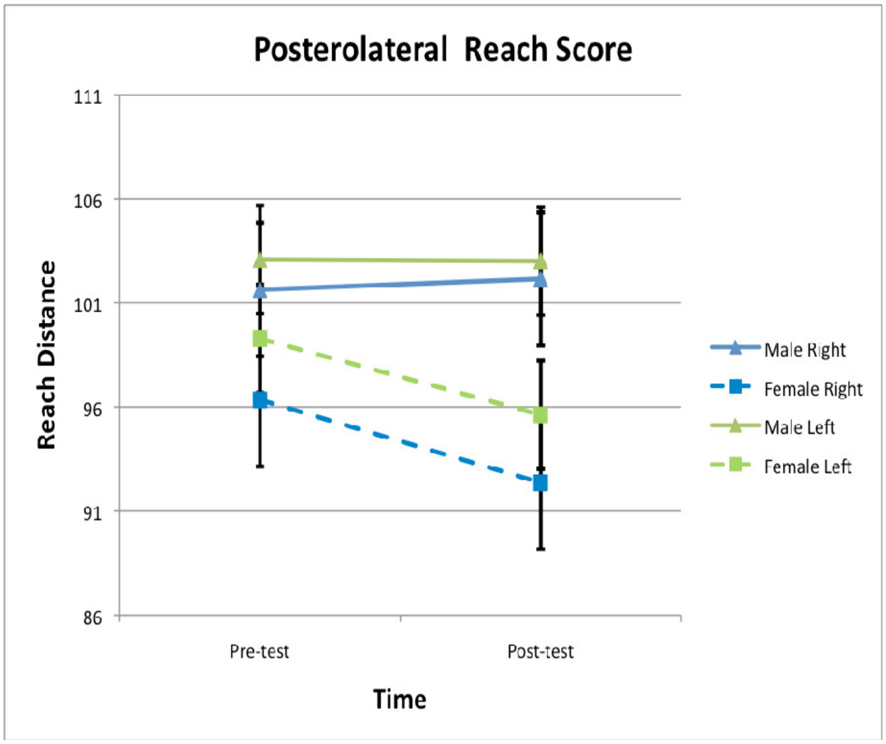

Figure 6. Right and left posterolateral reach scores

1.4 Discussion

The main finding of this study was that following a functional fatigue protocol; female reach distance was significantly less than that of the male as assessed by the left composite reach score. Similarly, although not significant, the right composite reach score also demonstrated a trend in scores between males and females post-fatigue. There were also significant group main effects involving the individual reach scores for both right PM and left PM reaches. The decrease in the female composite reach scores post-fatigue suggests that the female adolescent athletes were more affected by fatigue as measured in this study. This decline in reach post-fatigue could hypothetically predispose an individual to injury as previous literature has repeatedly linked fatigue with an increased risk for injury.[10, 32, 33] It has been documented that poor or abnormal neuromuscular muscular control of the lower limb biomechanics is a primary contributor to the female ALC injury mechanism.[34] If a stabilizing mechanism such as the quadriceps-hamstring co-activation was to fail due to fatigue; the stress imposed on the joint will increase. If the muscles are unable to generate the proper force for stabilization, an excessive load would be placed upon the ligamentous restraints, potentially resulting in an injury. Considering that the YBT is a dynamic test that requires strength, flexibility, and proprioception, a fatigue induced reach deficit could be considered as a physical marker of an individual's level of fatigue.

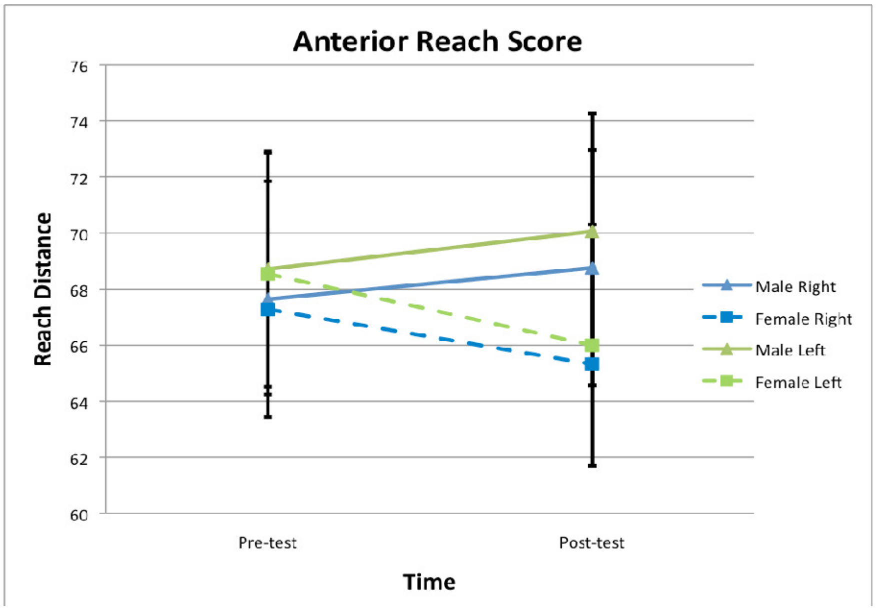

Figure 7. Right and left anterior reach scores

Potential causes for the differences in reach distances reported in this study could be the amount of repetitions completed before the females reached the fatigued state as determined by the FFP protocol. The females averaged 6 FFP repetitions versus 20 repetitions for the males suggesting a greater effect of fatigue on females. This has been supported by tests conducted on fatigue induced via dynamic muscle contractions, as well as in fatigue protocols associated with a cognitive load.[35] When environmental conditions are such that women perceive an increase in stress compared to control conditions, the gender difference in time to task failure can be diminished.[35] Furthermore, Yoon et al demonstrated that muscle fatigability can be exacerbated during performance of a cognitive task that increases arousal (mental-attentiveness task) more so in women than men suggesting that females would be more adversely affected by competition-induced fatigue.[36] Within the competitive environment, fatigue and decision making capabilities rarely exist independent of one another. Considering both central and peripheral processing mechanisms are compromised in the presence of fatigue,[14, 37] poor perceptions, decisions, reactions and resultant movement strategies may be more likely to occur when in a fatigued state.[24] This finding may have implications as to the causes of the increased number of severe female injuries compared to males.[1, 34] Previous studies have reported have that fatigue-induced change in knee mechanics may precipitate increased ACL injury risk, particularly in women.[24] Hewett et al. reported that female knees that suffered ACL injuries had greater knee abduction angles in a jump-landing task than that of the non injured control subjects.[34] Furthermore, Borotikar et al. found increases in initial contact hip rotations and in knee abduction angles in jump landings when female subjects were in a fatigued state.[24] These fatigue-induced increases in initial contact hip rotations and in peak knee abduction angle were also significantly more pronounced during unanticipated compared to anticipated landings.[38] These findings suggest that females may adapt different strategies for neuromuscular control during activity, and that fatigue further alters these strategies. This corresponds to the significant group by time interaction seen for the left composite reach score in this study.

One of the goals of this study was to achieve a fatigued state that matches as closely as possible the fatigue and mental stresses that an athlete experiences in an actual competition. Previous studies have reported that fatigue had less of an effect on females after a fatiguing protocol.[5, 38] However, the methods used to achieve fatigue consisted of submaximal, low intensity fatigue-inducing protocols performed on an isokinetic dynamometer, a repeated lunging task, calf raises, or seated rowing ergometer.[5, 38] While these methods were successful in achieving fatigue, perhaps it is not directly comparable to the total body, functional fatigue induced in our study.[26, 39] It has been reported that there is a higher number of severe injuries and surgeries in female athletes at the high school level [1]; this could be attributed to fatigue induced alterations in biomechanical and neuromuscular strategies for maintaining postural control.[24, 26, 38, 40, 41] The results of our study indicating a decrease in composite reach distances in females adds support to the notion that alterations occur as a result of fatigue. We argue that the FFP used in this study is unique in that it replicates activities commonly seen in athletic competition such as; cutting, sprinting, back-peddling followed by a cutting maneuver, jump-landings from various heights, and that such a protocol should be considered in future studies involving fatigue. The method in which the protocol is carried out, with short rest periods, between repetitions, also mimics the starting and stopping activities that take place in sports such as soccer and basketball.

1.4.1 Limitations and Future Investigations

One of the limitations of this study was the issue of errors committed while performing the YBT. An error was defined as the inability to maintain single leg stance on the platform while pushing the moveable reach indicator in a controlled manner. Both male and female participants had in increase in reach errors while performing the post-fatigue measurements. Another possible limitation was the height of 60.96 cm plyometric box. Some females were excluded from participating in the study due to an inability to jump onto the highest plyometric box jump. In future studies using the FFP, a plyometric box with the height of 45.72cm (the same height as the second plyometric box) could be substituted for the 60.96cm box if necessary.

Future studies may focus on the identification of fatigue markers that may be present during an athletic practice or competition. This could potentially lead to a change in the way athletes are monitored during athletics. The preventative message for clinicians may be the identification of subjects in a fatigued state that may be beyond the athlete's ability to maintain normal biomechanical movements. A test such as the BESS could be conducted on the sideline and used to evaluate the athlete to determine if more rest is needed to prevent an injury situation. Further studies may also look at the effect of a balance training intervention on this population.

1.4.2 Clinical Implications

The main findings of this study are that females reach distance was significantly different than that of the males involving the left composite reach score post fatigue as measured by the YBT. The right composite reach score also demonstrated a similar trend between males/females post fatigue. In both instances, females were negatively affected by fatigue. The findings of this current study, combined with previous research, provide potential insight into the response to high school athletes when in a fatigued condition similar to that of competition. The increased negative response by females in this study may provide a connection to the overall higher incidence of female severe injuries seen in high school athletics.

Chapter 2

SPECIFIC AIMS

More that 7 million students are involved in high school sports annually in the United States. [1] Along with the increasing number of adolescent participants comes an estimated 2.5 million sports-related emergency room visits per year.[1] High school athletes were responsible for more than 1.4 million injuries during the 2005–2006 school year.[2] With so many young people active and sustaining injuries in high school athletics, it is important that this population be studied, and the mechanism by which these injuries are produced be determined

Success in high school athletics involves several components of fitness including strength, cardiovascular endurance, proprioception, coordination, and balance. Balance is generally considered an important component of athletic activities and is required for sport. [3] Balance, or postural control, has been described as both static and dynamic. Static postural control is an attempt to maintain a base of support with minimal movement of the body segments and maintaining one's center of mass.[4] Dynamic postural control involves controlling one's center of mass while the base of support is moving. [5] The inability to maintain postural control has been associated with a general risk for injury in sport.[3] Poor postural control abilities have also been linked with increased risk of ankle injuries in both male and female adolescent athletes. [6,7]

There are numerous ways in which a person sustains an injury during athletics and fatigue may be an important component in the cause of these injuries. Previous literature has reported that fatigue is responsible for: decreases in force production and neural drive; alterations in mechanics, peripheral feedback and postural stability; changes in reflexive function and muscle contractile properties; and modifications to other neuromuscular functions.[8] Fatigue can be implicated as a causative factor in sport- related injuries, with strong epidemiological evidence that contends that up to 71% of all injuries occur late in competitions or practice.[9, 10] It is also important to note that 58% of these injuries result from some non-contact mechanism which suggests a failure in neuromuscular control. [9] Fatigue is believed to increase the threshold of muscle-spindle discharge, which disrupts the afferent feedback, subsequently altering afferent information into the central nervous system and joint awareness. [11] The afferent information is a critical portion of the feedback loops that help create and maintain postural control.[5] Any of these factors could potentially increase the risk for injury, yet previous studies predicting fatigue-related effects may have used insufficient methods to achieve fatigue in the subjects.[12] In addition, further study needs to be done on the effect gender has on dynamic postural control and injury.

Several previous investigations have employed controlled interventions to achieve a fatigued state, including isometric and isokinetic contractions. [5, 11, 13-17] It is possible that these results are not able to be directly related to the fatigue that results from a sporting competition or practice. This study will attempt to fatigue male and female subjects using a protocol that simulates activities commonly associated with athletic competition. Therefore, the purpose of this study will be to examine the effects of a functional fatigue protocol on measures of dynamic postural control using the SEBT.

Specific Aim 1: To identify if differences in performance of the SEBT are present between the non-fatigued and fatigued conditions.

Hypothesis 1.1: SEBT scores will decrease significantly following the FFP when compared to baseline scores. While the exact relationship between fatigue and injury is unclear; it has been hypothesized to cause alterations in neuromuscular and biomechanical properties, thus increasing the risk for injury.[18]

Specific Aim 2: To identify if differences in performance of the SEBT are present between genders.

Hypothesis 2.1: There will be a significant difference between the performance of the SEBT between males and females. Although we expect deficits in both genders in the SEBT after the FFP, we hypothesize the deficits will be larger in females versus males. Hicks et al reported that women experienced a reduction in the time to task failure of dynamic contractions with the addition of a cognitive load.[19] Ingram et al [1] reported a higher rate (2.5 times more injures for females) of major knee trauma including complete ligament tears and season-ending injuries to female athletes than males at the high school level.

Chapter 3

BACKGROUND AND SIGNIFICANCE

It is important to study the high school athletic population in order to understand and identify the cause of injuries that may occur to these athletes. With an estimated 2.5 million adolescents visiting the emergency room each year as a result of sport-related injuries, it is also an economic burden.[1] Some injuries such as sprains, strains, or contusions, require minimal medical attention, however, injuries like fractures, ligament tears, and dislocations will significantly increase the costs of medical care. Knee surgeries alone account for as many as 60% of all sport-related surgeries.[20] This type of surgery is not only very costly, but can involve extensive rehabilitation procedures and increase the risk for early onset osteoarthritis.[1] The need for expensive long-term rehabilitation makes the identification and prevention of these potential injuries essential for the adolescent population.

3.1 Epidemiology of High School Injuries

Over 7 million students participate in high school athletics annually. Despite the many health benefits that come with athletics, there is still a risk of injury.[20] In a study by Darrow et al, which looked at the incidence of severe injuries in high school athletes over a two year period, certified athletic trainers (ATCs) reported 1378 severe injuries during 3,550,141 athlete-exposures. An "athlete-exposure" counts as all practices and games in which the athletes are involved. Nationally, high school athletes sustained an estimated 446,715 severe injuries from 2005-2007. The most commonly injured body sites were the knee (29.0%), ankle (12.3%), and shoulder (10.9%). The most common diagnoses were fractures (36.0%), complete ligament sprains (15.3%), and incomplete ligament sprains (14.3%). Of severe sports injuries, 0.3% qualified as career ending injuries, and an additional 56.8% resulted in the loss of the entire season. One in 4 (28.3%) of the severe injuries required surgery, with over half (53.9%) being knee surgeries.[20] Among sports, football had the highest severe injury rate, followed by wrestling, girls' basketball, and girls' soccer. However, when injury rates were compared among similar sports (soccer, basketball, and baseball/softball), girls sustained a higher severe injury rate than boys. Research needs to be done with the focus on identifying risk factors and developing interventions to decrease the incidence and severity of sport-related injuries especially in the high school population.

3.2 Postural Control

Postural control is generally considered an important component of athletic activities. Success in high school athletics involves several components of fitness including strength, cardiovascular endurance, proprioception, coordination, and balance. Balance, or postural control, has been described as static or dynamic. Static postural control is an attempt to maintain a base of support with minimal movement of the body segments and the center of mass.[4] Dynamic postural control involves controlling one's center of mass while the base of support is moving.[13] Dynamic control is especially important in sport because it requires the integration of the necessary levels of proprioception, range-of-motion, and strength.[4] These factors need constant adjustment and the ability or inability to successfully adjust to changing demands could determine who is more likely to sustain an injury. The inability to maintain postural control has previously been associated with a general risk for injury in sport.[3] Poor balance abilities have also been linked with increased risk of ankle injuries in both male and female adolescent athletes.[7] Recent literature has discussed the importance of assessing dynamic postural control for injury prediction using body relative movement.[3]

3.2.1 *Star Excursion Balance Test*

A clinically applicable dynamic proprioception measurement test is the Star Excursion Balance Test (SEBT). The SEBT requires strength, flexibility, and proprioception. It has been used to measure physical performance, compare balance abilities among different sports, and identify injured populations. The SEBT has also been used to identify athletes at a greater risk for lower extremity injuries [21] and to classify and categorize chronic ankle instability.[3] The results of SEBT can provide a functional measure of a subject's dynamic postural control while in a standing position as opposed to measurements taken in a static position, i.e. single leg stance tests or force plate measurements. Hertel et al described a SEBT testing grid consisting of eight lines, each 120 cm in length extending from a common point at 45 degree angle increments. [22] The reach directions include anterior, lateral, posterior, medial, anteromedial, anterolateral, posteromedial, and posterolateral. The goal of the SEBT is to maintain single leg stance on one leg while reaching as far as possible with the opposite leg along one of the reach lines. [3, 13] Subsequent testing and analysis of the SEBT by Plisky et al determined that three reach directions, anterior, posteromedial, and posterolateral, are accurate in determining a subject proprioceptive abilities. [3] Plisky et al reported that the sum of three reach directions, as well as asymmetry between legs in the anterior reach direction, were predictive of lower extremity injuries to high school basketball players.[21] For this research study, The Y Balance Test™ (YBT), an instrumented device based directly on the SEBT, will be used to measure reach distances. The YBT has shown good to excellent reliability in previous research. [3]

3.3 Fatigue

This study will attempt to identify what role fatigue has in relation to dynamic postural control in the high school population, and if differences can be observed using the YBT. Previous studies have shown that fatigue may impair the proprioceptive and kinesthetic properties of joints and has been shown to have a negative effect on neuromuscular control, thus increasing the risk for injury.[5] Fatigue has also been shown to increase the threshold of muscle spindle discharge, which disrupts the afferent feedback, subsequently altering joint awareness.[23] Previous literature has demonstrated that fatigue is responsible for: decreases in force production and neural drive; alterations in mechanics, peripheral feedback and postural stability; changes in reflexive function and muscle contractile properties; and modifications to other neuromuscular functions.[9, 10] Fatigue can be implicated as a causative factor in sport related injuries, with strong epidemiological evidence that contends that 54 to 71% of all injuries occur late in competitions or practice.[9] It is also important to note that 58% of these injuries result from some non-contact mechanism.[9] Ingram et al also reported that alterations in neuromuscular and biomechanical properties in the lower limbs resulting from fatigue, is a primary contributor to the female ACL injury mechanism.[1] Any of these factors could potentially increase the risk for injury, yet previous studies predicting fatigue related effects may have used methods to achieve fatigue in the subjects that are not functional in nature. Prior investigations have employed controlled interventions, such as isometric and isokinetic contractions, to achieve a fatigued state. [5, 13-17] It is possible that these results are not able to be directly related to the fatigue that results from a sporting competition or practice. [12] This type of sport-induced fatigue, followed by a test of dynamic postural control, has not been extensively studied in the adolescent population. While the detrimental effect of isokinetically and isometrically induced fatigue on postural control has been established in previous literature, [5, 11, 13-15]less is known about the effects of a functionally induced fatigue on dynamic postural control in adolescents. Many of the previous studies conducted on postural control and fatigue often focus on chronically unstable ankles or subjects with a history of previous lower body injuries. [5, 11, 13, 15] Fatigue induced changes in postural stability can lead to miscues during running, change in direction, jump landings and other dynamic movements that could result in an unintentional injury.[12] In this study, we will be putting subjects through a functional fatigue protocol consisting of sprints, side shuffling, backpedal exercises, as well as plyometric box jumps. Our rationale for this type of protocol is to achieve physical as well as mental fatigue, similar to fatigue achieved during athletic activity. This study will focus on how fatigue that has been achieved in a functional setting will affect dynamic postural control, as measured by the SEBT, of male and female high school athletes.

APPENDIX A: APPROVED INFORMED CONSENT DOCUMENTS

University of Delaware Human Subjects
Informed Consent Form

Research Study: The Effects of Fatigue on Dynamic Stability as Measured by the Star Excursion Balance Test

Investigators: Megan O'Neill and Dr. Thomas W. Kaminski, PhD (Dept. of Health, Nutrition, and Exercise Sciences)

INTRODUCTION
You have been invited to take part in a research project to gain information about fatigue and balance during athletic activities, and how athletic performance may be impacted. You qualify for this study because you are a student-athlete at Hodgson Vocational-Technical High School.

PURPOSE
The purpose of this research project is to study the effects of fatigue on balance during an activity that simulates athletic performance.

PROCEDURES
You are one of approximately 30 subjects being asked to participate in this study. The study will involve testing on two separate occasions. You will wear athletic clothing including running shoes, t-shirt, and shorts during the testing.

Session I (30 minutes) - You will provide the tester with information related to age, height, weight, and gender as well as complete a questionnaire related to physical activity. You will then learn and practice the Star Excursion Balance Test (SEBT). The SEBT consists of standing on one leg and moving the other leg in three different directions. The moving leg follows the test lines that have been laid out on the floor in the shape of a large "peace" symbol. You will be tested on your dominant leg (leg that would be used to kick a ball). You will be asked to reach as far as possible, without losing your balance, and touch down your big toe in the direction you are moving. A total of 4 trials are performed in each of the three directions. Once comfortable with the SEBT, you will be asked to sign-up for a separate one-day testing session (1 hour).

Session II (60 minutes) - All testing will take place in the high school's gymnasium. The test session will begin by having you complete the SEBT protocol (as described above) followed by a brief warm-up consisting of five minutes on a stationary bike and stretching of the thigh and calf muscles. You will then be asked to complete an exercise protocol that consists of performing a series of sprinting, hopping, shuffling, and jumping tasks using maximal effort. The timed exercise routine is meant to simulate activities encountered during sporting activities. You will be given the opportunity to "walk-through" the exercise protocol before beginning the testing. In addition, any questions you have on proper execution will be answered. The SEBT protocol will be repeated at the conclusion of the exercise protocol followed by a 5-minute cool-down period of lower body stretching activities. The exercise protocol will be closely monitored at all times by a certified athletic trainer qualified to administer the test.

CONDITIONS OF SUBJECT PARTICIPATION

All of the data will be kept confidential. Your information will be assigned a code number. The list connecting your name to the code number will be kept in a locked file. When the study is completed and the data have been analyzed, that list will be destroyed, but the coded data will be kept indefinitely in order to evaluate the data at a future time if it is needed by the investigator. Your name will not be used in conjunction with this study. In the event of physical injury during participation, you will receive first aid. If you require additional medical treatment, you will be responsible for the cost. There are no consequences for withdrawing from the study and you can do so at any time. Stopping or withdrawing will not affect your status at school or on your athletic team.

RISKS AND BENEFITS

You may also develop leg cramps, dehydration and/or muscle soreness in the lower body for a day or two following testing. There is a slight risk to you of suffering bone, muscle, or joint injuries during the exercise protocol. Though extremely rare, any exercise may cause shortness of breath, abnormal blood pressure, irregular heartbeat, and in extreme cases, heart attack or death. Every effort will be made to minimize these risks by continuously monitoring you throughout the test. It is your responsibility to inform the investigator of any symptoms you are feeling during or after the exercise protocol. The exercise protocol is comprised of typical athletic maneuvers and intensities common to high school athletic practices and games. The exercise protocol will not exceed the intensity experienced in a typical practice or game. In the event of an acute injury, you will receive immediate first aid. You will be responsible for any follow-up care. By participating in this study you may gain information about your fitness level and balance performance.

FINANCIAL CONSIDERATIONS

There will be no compensation for participating in this study. There will be no cost to you, the subject, for participating in the study and all materials will be provided by the researcher.

CONTACTS

Megan O'Neill (302) 897-1701 or moneill@udel.edu & Dr. Thomas W. Kaminski (302) 831-6402 or kaminski@udel.edu Questions regarding the research study can be directed to the above email addresses. For questions of concerns about the rights to the individuals who agree to participate in the study: Human Subjects Review Board, University of Delaware (302) 831-2137

MEDICAL RELEASE

By signing this document, you are granting access to your school medical record to the investigator. This information will only be used to qualify you for participation in this study.

Subject Signature Date

ASSURANCE

Participation in this study is completely voluntary. Refusal or choosing to discontinue participation in this study is the right of the individual, with no loss of benefits to which the subject is otherwise entitled.

CONSENT SIGNATURES

Subject Consent Signature Date

Principal Investigator Signature Date

University of Delaware Human Subjects
Informed Assent for Minors

Research Study: The Effects of Fatigue on Dynamic Stability as Measured by the Star Excursion Balance Test

Investigators: Megan O'Neill and Dr. Thomas W. Kaminski, PhD (Dept. of Health, Nutrition, and Exercise Sciences)

INTRODUCTION

You have been invited to take part in a research project to gain information about fatigue and balance during athletic activities, and how athletic performance may be impacted. You qualify for this study because you are a student-athlete at Hodgson Vocational-Technical High School.

PURPOSE

The purpose of this research project is to study the effects of fatigue on balance during an activity that simulates athletic performance.

PROCEDURES

You are one of 30 subjects being asked to participate in this study. The study will involve testing on two separate days. You will wear athletic clothing including running shoes, t-shirt, and shorts during the testing.

Session I (30 minutes) - You will provide the tester with information related to age, height, weight, and gender as well as complete a questionnaire related to physical activity. You will then learn and practice the Star Excursion Balance Test (SEBT). The SEBT consists of standing on one leg and moving the other leg in three different directions. The moving leg follows the test lines that have been laid out on the floor in the shape of a large "peace" symbol. You will be tested on your dominant leg (leg that would be used to kick a ball). You will be asked to reach as far as possible, without losing your balance, and touch down your big toe in the direction you are moving. A total of 4 trials are performed in each of the three directions. Once comfortable with the SEBT, you will be asked to sign-up for a separate testing session.

Session II (60 minutes) - This session will take place in the high school's gymnasium. First you will complete the SEBT protocol (as described above) followed by a brief warm-up consisting of five minutes on a stationary bike and stretching of the thigh and calf muscles. You will then be asked to complete an exercise protocol which consists of performing a series of sprinting, hopping, shuffling, and jumping tasks using maximal effort. The exercise routine is meant to simulate activities encountered during sporting activities. You will be given the opportunity to "walk-through" the exercise protocol before beginning the testing. In addition, any questions you have on proper execution will be answered. The SEBT protocol will be repeated at the conclusion of the exercise protocol followed by a 5-minute cool-down period of lower body stretching activities. The exercise protocol will be closely monitored at all times by a certified athletic trainer qualified to administer the test.

CONDITIONS OF SUBJECT PARTICIPATION

All of the data will be kept confidential. Your information will be assigned a code number. The list connecting your name to the code number will be kept in a locked file. When the study is completed and the data have been analyzed, that list will be destroyed, but the coded data will be kept indefinitely to be used in research. Your name will not be used in conjunction with this study. In the event of physical injury during participation, you will receive first aid. If you require additional medical treatment, your parents/guardian will be responsible for the cost. You may stop participating or withdraw from the study at any time. Stopping or withdrawing will not affect your status at school or on your athletic team.

RISKS AND BENEFITS

You may also develop leg cramps, dehydration and/or muscle soreness in the lower body for a day or two following testing. There is a slight risk to you of suffering bone, muscle, or joint injuries during the exercise protocol. Though extremely rare, any exercise may cause shortness of breath, abnormal blood pressure, irregular heartbeat, and in extreme cases, heart attack or death. Every effort will be made to minimize these risks by continuously monitoring you throughout the test. It is your responsibility to inform the investigator of any symptoms you are feeling during or after the exercise protocol. The exercise protocol is comprised of typical athletic maneuvers and intensities common to high school athletic practices and games. The exercise protocol will not exceed the intensity experienced in a typical practice or game. In the event of an acute injury, you will receive immediate first aid. Follow-up care will be at your parents'/guardians' expense. By participating in this study you may gain information about your fitness level and balance performance.

FINANCIAL CONSIDERATIONS

There will be no compensation for participating in this study. There will be no cost to you for participating in the study and all materials will be provided by the researcher.

CONTACTS

Megan O'Neill (302) 897-1701 or moneill@udel.edu & Dr. Thomas W. Kaminski (302) 831-6402 or kaminski@udel.edu Questions regarding the research study can be directed to the above email addresses. For questions of concerns about the rights to the individuals who agree to participate in the study: Human Subjects Review Board, University of Delaware (302) 831-2137.

ASSURANCE
Participation in this study is completely voluntary. Refusal or choosing to discontinue participation in this study is the right of the individual, with no loss of benefits to which the subject is otherwise entitled.

CONSENT SIGNATURES

Subject Consent Signature Date

Principal Investigator Signature Date

Signed consent forms will be retained by the researcher for three years after completion of the research.

University of Delaware Human Subjects
Parental Consent Form for Minors

Research Study: The Effects of Fatigue on Dynamic Stability as Measured by the Star Excursion Balance TestInvestigators: Megan O'Neill and Dr. Thomas W. Kaminski, PhD (Dept. of Health, Nutrition, and Exercise Sciences)

INTRODUCTION
Your child has been invited to take part in a research project to gain information about fatigue and balance during athletic activities, and how athletic performance may be impacted. Your child's qualification for this study is based on his/her being a varsity student-athlete at Hodgson Vocational-Technical High School with a completed and approved DIAA physical form.

PURPOSE
The purpose of this research project is to study the effects of fatigue on balance during an activity that simulates athletic performance.

PROCEDURES
Your child is one of 30 subjects being asked to participate in this study. The study will involve testing on two separate occasions. Your child will wear athletic clothing including running shoes, t-shirt, and shorts during the testing.

Session I (30 minutes) - Your child will provide the tester with information related to age, height, weight, and gender as well as complete a questionnaire related to physical activity. Your child will then learn and practice the Star Excursion Balance Test (SEBT). The SEBT consists of standing on one leg and moving the other leg in three different directions. The moving leg follows the test lines that have been laid out on the floor in the shape of a large "peace" symbol. Your child will be tested on his/her dominant leg (leg that would be used to kick a ball). Your child will be asked to reach as far as possible, without losing his/her balance, and touch down his/her toe in the direction he/she is moving. A total of 4 trials are performed in each of the three directions. Once comfortable with the SEBT, your child will be asked to sign-up for a separate one-day testing session (1 hour).

Session II (60 minutes) - This session will take place in the high school's gymnasium. The test session will begin with your child completing the SEBT protocol followed by a brief warm-up consisting of five minutes on a stationary bike and stretching of the thigh and calf muscles. Your child will then be asked to complete a timed exercise protocol which consists of him/her performing a series of sprinting, hopping, shuffling, and jumping tasks using maximal effort. The exercise routine is meant to simulate activities encountered during sporting activities. Your child will be given the opportunity to "walk-through" the exercise protocol before beginning the testing. In addition, any questions he/she has on proper execution will be answered. The SEBT will be repeated at the conclusion of the exercise protocol followed by a 5-minute cool-down period of lower body stretching activities. The exercise protocol will be closely monitored at all times by a certified athletic trainer qualified to administer the test.

CONDITIONS OF SUBJECT PARTICIPATION
All of the data will be kept confidential. Your child's information will be assigned a code number. The list connecting his/her name to the code number will be kept in a locked file. When the study is completed and the data have been analyzed, that list will be destroyed, but the coded data will be kept indefinitely for future research. Your child's name will not be used in conjunction with this study. In the event of physical injury during participation, your child will receive first aid. If additional medical treatment is required, you will be responsible for the cost. Your child will be removed from the study if he/she experiences any injury that interferes with the results or prevents him/her from completing the test. There are no consequences for withdrawing from the study and your child can choose to stop or withdraw at any time. You can also withdraw your child at any time.

RISKS AND BENEFITS
The risks associated with exercise include shortness of breath, abnormal blood pressure, irregular heartbeat, and in extreme cases, heart attack or death. Your child may also develop leg cramps, dehydration and/or muscle soreness in the lower body 24 - 48 hours following testing. There is a slight risk to your child of suffering bone, muscle, or joint injuries during the exercise protocol. The exercise protocol is comprised of typical athletic maneuvers and intensities common to high school athletic practices and games. The exercise protocol will not exceed the intensity experienced in a typical practice or game. Every effort will be made to minimize these risks by continuously monitoring your child throughout the test. It is your child's responsibility to inform the investigator of any symptoms he or she is feeling during or after the exercise protocol that warrant stopping the test. Otherwise, testing will continue until the established finish criteria have been met. In the event of an acute injury, your child will receive immediate first aid. Follow-up care will be at your own expense. By participating in this study your child may gain information about his/her fitness level and balance performance.
FINANCIAL CONSIDERATIONS
There will be no compensation for participating in this study. There will be no cost to you or your child for participating in the study and all materials will be provided by the researcher.

CONTACTS
Megan O'Neill (302) 897-1701 or moneill@udel.edu & Dr. Thomas W. Kaminski (302) 831-6402 or kaminski@udel.edu Questions regarding the research study can be directed to the above email addresses. For questions of concerns about the rights to

the individuals who agree to participate in the study: Human Subjects Review Board, University of Delaware (302) 831-2137.

MEDICAL RELEASE
By signing this document, you are granting access to your school medical record to the investigator. This information will only be used to qualify you for participation in this study.

____
Parent Signature Date

ASSURANCE
I have read the above parental consent document. 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 my son/daughter's participation in this study at any time without penalty or loss of benefit. A copy of this parental consent form has been given to me.

CONSENT SIGNATURES

Parent's Signature: ____ Date:_____

Child's Name (printed): ____

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation of their son/daughter in this research study; have answered any questions that have been raised; and have witnessed the above signature. I have provided the parent/guardian with a copy of this parental consent document.

Signature of the Investigator:
______________________________________Date:______

Signed consent forms will be retained by the researcher for three years after completion of the research

APPENDIX B: DIAA PHYSICAL EVALUATION
DELAWARE INTERSCHOLASTIC ATHLETIC ASSOCIATION

Parents/Guardian: The DIAA pre-participation physical evaluation and consents form is a five page document. Pages one, two and four require your signature while page five is a reference for you to keep. This physical evaluation must be completed after April 1 of the current year playing sports and runs through June 30 of the following year.

Athlete: _________________ Phone: ___________ School: _____________
Age:________ Gender: ________ Date of Birth: _________ Grade: ______
Parent/Guardian Name: (Please Print) ___________________________________

PARENT/GUARDIAN CONSENTS

________________________ Has my permission to participate in all interscholastic (Name of Athlete) sports **not checked below**.

If you check any sport in this box it means the athlete will not be permitted to participate in that sport.

Collision Contact Non-Contact
__ football _ ice hockey __ volleyball ___ softball __ cross country ___tennis
__ soccer _ boys' lacrosse __ field hockey ___ baseball __ swimming ___golf
__ wrestling __ basketball ___ girls lacrosse __ track ___crew
__squash __ cheerleading

1. My permission extends to all interscholastic activities whether conducted on or off school premises. I
have read and discussed page 5, which is the list of items that protect against the loss of athletic
eligibility, with said participant and I will retain that page for my reference. I have also discussed with
him/her and we understand that physical injury, including paralysis, coma or death can occur as a
result of participation in interscholastic athletics. I waive any claim for injury or damage incurred by
said participant while participating in the activities not checked above.

Parent Signature: _____________________________ **Date**: ___________________

2. To enable DIAA and its full and associate member schools to determine whether herein named student
is eligible to participate in interscholastic athletics, I hereby consent to the release of any and all
portions of school record files, beginning with the sixth grade, of the herein named student, including

but not limited to, birth and age records, name and residence of student's parent(s), guardian(s) or
Relative Care Giver, residence of student, health records, academic work completed, grades received
and attendance records.

Parent Signature: ______________________________ **Date**: ___________________

3. I further consent to DIAA's and its full and associate member schools use of the herein named
student's name, likeness, and athletically related information in reports of interscholastic practices,
scrimmages or contests, promotional literature of the Association, and other materials and releases
related to interscholastic athletics.

Parent Signature: ______________________________ **Date**: ___________________

4. By this signature, I hereby consent to allow the physician(s) and other health care providers(s) selected
by myself or the schools to perform a pre-participation examination on my child and to provide
treatment for any injury received while participating in or training for athletics for his/her school. I
further consent to allow said physician(s) or health care provider(s) to share appropriate information
concerning my child that is relevant to participation, with coaches, medical staff, Delaware
Interscholastic Athletic Association, and other school personnel as deemed necessary. Such
information maybe used for injury surveillance purposes.

Parent Signature: _______________________________ **Date**: _________________

DIAA Preparticipation Physical Evaluation HISTORY FORM

DATE OF EXAM

Name Sex Age Date of birth

Grade School Sport(s)

Address Phone

Personal physician

In case of emergency, contact

Name Relationship Phone (H) (W)

Explain "**YES"** answers below.

Circle questions you don't know the answers to.

Yes No

1. Has a doctor ever denied or restricted your participation in sports for any reason? □ □
2. Do you have an ongoing medical condition (like diabetes or asthma)? □ □
3. Are you currently taking any prescription or nonprescription (over-the-counter) medicines or pills? □ □

4. Do you have allergies to medicines, pollens, foods,
or stinging insects? □ □
5. Have you ever passed out or nearly passed out
DURING exercise? □ □
6. Have you ever passed out or nearly passed out
AFTER exercise? □ □
7. Have you ever had discomfort, pain, or pressure in
your chest during exercise? □ □
8. Does your heart race or skip beats during exercise? □ □
9. Has a doctor ever told you that you have
(check all that apply):
□ High blood pressure □ A heart murmur
□ High cholesterol □ A heart infection
10. Has a doctor ever ordered a test for your heart?
(for example, ECG, echocardiogram) □ □
11. Has anyone in your family died for no apparent reason? □ □
12. Does anyone in your family have a heart problem? □ □
13. Has any family member or relative died of heart
problems or of sudden death before age 50? □ □
14. Does anyone in your family have Marfan syndrome? □ □
15. Have you ever spent the night in a hospital? □ □
16. Have you ever had surgery? □ □
17. Have you ever had an injury, like a sprain, muscle or
ligament tear, or tendinitis, that caused you to miss a
practice or game? If yes, circle affected area below: □ □
18. Have you had any broken or fractured bones or
dislocated joints? If yes, circle below: □ □
19. Have you had a bone or joint injury that required x-rays,
MRI, CT, surgery, injections, rehabilitation, physical
therapy, a brace, a cast, or crutches? If yes, circle below: □ □
Head
Neck
Shoulder
Upper
arm
Elbow
Forearm
Hand/
fingers
Chest
Upper
back
Lower
back
Hip
Thigh
Knee
Calf/shin
Ankle
Foot/toes
20. Have you ever had a stress fracture? □ □
21. Have you been told that you have or have you had
an x-ray for atlantoaxial (neck) instability? □ □
22. Do you regularly use a brace or assistive device? □ □
23. Has a doctor ever told you that you have asthma
or allergies? □ □
24. Do you cough, wheeze, or have difficulty breathing
during or after exercise? □ □
25. Is there anyone in your family who has asthma? □ □
26. Have you ever used an inhaler or taken asthma medicine? □ □
27. Were you born without or are you missing a kidney,
an eye, a testicle, or any other organ? □ □
28. Have you had infectious mononucleosis (mono)
within the last month? □ □
29. Do you have any rashes, pressure sores, or other
skin problems? □ □
30. Have you had a herpes skin infection? □ □
31. Have you ever had a head injury or concussion? □ □

32. Have you been hit in the head and been confused
or lost your memory? □ □
33. Have you ever had a seizure? □ □
34. Do you have headaches with exercise? □ □
35. Have you ever had numbness, tingling, or weakness
in your arms or legs after being hit or falling? □ □
36. Have you ever been unable to move your arms or
legs after being hit or falling? □ □
37. When exercising in the heat, do you have severe
muscle cramps or become ill? □ □
38. Has a doctor told you that you or someone in your
family has sickle cell trait or sickle cell disease? □ □
39. Have you had any problems with your eyes or vision? □ □
40. Do you wear glasses or contact lenses? □ □
41. Do you wear protective eyewear, such as goggles or
a face shield? □ □
42. Are you happy with your weight? □ □
43. Are you trying to gain or lose weight? □ □
44. Has anyone recommended you change your weight
or eating habits? □ □
45. Do you limit or carefully control what you eat? □ □
46. Do you have any concerns that you would like to
discuss with a doctor? □ □

FEMALES ONLY

47. Have you ever had a menstrual period? □ □
48. How old were you when you had your first menstrual period?
49. How many periods have you had in the last 12 months?

Explain "Yes" answers here:

I hereby state that, to the best of my knowledge, my answers to the above questions are complete and correct.

Signature of athlete Signature of parent/guardian Date

PREPARTICIPATION PHYSICAL EVALUATION

DIAA PRE-PARTICIPATION PHYSICAL EVALUATION

Name____ Date of Birth______________________

Height__________ Weight_________ %Body fat (optional)________ Pulse__________ BP___/___(___/___)

Vision R 20/___ L20/___ Corrected: Y N Pupils: Equal____ Unequal____ Risk behaviors discussed: Y N

(diet, weight, driving, drugs, alcohol, sexuality, safety, stress)

Please choose one of the following four (4) options:

___1. Cleared without restriction
___2. Cleared, with recommendations for further evaluation or treatment for:
____
___3. **Not Cleared, but needs additional evaluation by (whom):*____
___4. Not Cleared for either ___All sports ___Certain sports:____
Reason:____

Please note any necessary equipment, medications, or restrictions for cleared athlete to play or practice:

By this signature, I hereby state that I have performed a pre-participation examination in accordance with DIAA standards (current edition of Physician and Sports Medicine's Pre-participation Physical Evaluation) and certify that the above clearance and attached PPE

is accurate, complete and compliant to such standards. I also agree that I have documented and signed any playing restrictions on the
High School Athlete Medical Card (pg 4).
HealthCare Provider's Signature:____ Date:________________
Printed Name:____________________________________ Title:_______________ Phone:_______________
**If Option 3 checked then Referred Physician needs to complete below:*
____ Cleared- no restriction _____Cleared with the following restrictions:________________________________
____ Not Cleared for ___All sports ___Certain sports:____
Referred Physician Signature:______________________________Print:____________________
Date:__________

MEDICAL
Appearance
Eyes/ears/nose/throat
Hearing
Lymph nodes
Heart
Murmurs
Pulses
Lungs
Abdomen
Genitourinary(males
only)+
Skin
MUSCULOSKELETAL
Neck
Back
Shoulder/arm
Elbow/forearm
Wrist/hand/fingers
Hip/thigh
Knee
Leg/ankle
Foot/toes
*Multiple-examiner set-up only +Having 3rd party present is recommended for the genitourinary exam
Notes:
- 4 -

SCHOOL ATHLETE MEDICAL CARD

(Parent/Guardian: please print and complete Sections 1, 2 & 3)
***For office use only**: This card is valid from April 1, 20_______ through June 30, 20________*
Note: If any changes occur, a new card should be completed by the parent/guardian. The original card should be
kept on file in the school athletic director's or athletic trainer's office. A copy should be kept in the sports' athletic
kits. This card contains personal medical information and should be treated as confidential by the school, its
employees, agents, and contractors.
Name of School**: ______________________________ **Name of ATC:
____

SCHOOL ATHLETE MEDICAL CARD

(Parent/Guardian: please print and complete Sections 1, 2 & 3)
***For office use only**: This card is valid from April 1, 20_______ through June 30, 20________*
Note: If any changes occur, a new card should be completed by the parent/guardian. The original card should be
kept on file in the school athletic director's or athletic trainer's office. A copy should be kept in the sports' athletic

kits. This card contains personal medical information and should be treated as confidential by the school, its employees, agents, and contractors.
Name of School**:** ______________________________ ***Name of ATC:*** ______________________________

NAME:____ SPORT:________________
SS#:________________
AGE:____GRADE:____ BIRTH DATE:___________ GUARDIAN NAME:__________________________________
ADDRESS:____
PHONE: (H)_____________________ (W)_________________ (C)_________________
(P)_________________
Other authorized person to contact in case of emergency:
NAME:____
PHONE(s):_______________________________________
NAME:____
PHONE(s):_______________________________________
Preference of Physician (and permission to contact if needed):
NAME:____
PHONE:_____________________________
HOSPITAL PREFERENCE:______________________
INSURANCE:_____________________________________
POLICY #:________________________ GROUP:_________________________
PHONE:____________________

Section 2: **MEDICAL INFORMATION**

MEDICAL ILLNESSES:____
LAST TETANUS (mo/yr):____________
ALLERGIES:____
MEDICATIONS:____
(any medications that may be taken during competition require a physician's note)
PREVIOUS HEAD/NECK/BACK INJURY:____
PREVIOUS HEAT-RELATED PROBLEMS:____
PREVIOUS SIGNIFICANT INJURIES:____
ANY OTHER IMPORTANT MEDICAL INFORMATION:____

Section 3: **Consent for Athletic Conditioning, Training and Health Care Procedures**

I hereby give consent for my child to participate in the school's athletic conditioning and training program, and to receive any necessary healthcare treatment including first aid, diagnostic procedures, and medical treatment, that may be provided by the treating physicians, nurses, athletic trainers, or other healthcare providers employed directly or through a contract by

the school, or the opposing team's school. The healthcare providers have my permission to release my child's medical
information to other healthcare practitioners and school officials. In the event I cannot be reached in an emergency I give
permission for my child to be transported to receive necessary treatment. I understand that Delaware Interscholastic
Athletic Association or its associates may request information regarding the athlete's health status, and I hereby give my
permission for the release of this information as long as the information does not personally identify my child.

Parent/Guardian Signature:____
Date:_______________

Athlete's Signature:____ **Date**:_______________

***Section 4:* Clearance for Participation**

__ Cleared without restrictions __ Cleared with the following restrictions:

Health Care Provider's Signature:______________________________________ **MD/DO, PA,NP**
Date:__________

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