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Female Division I Cross Country Runners: Is Balance an Issue?

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FEMALE DIVISION I CROSS COUNTRY RUNNERS: IS BALANCE AN ISSUE?
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Introduction

Injuries, including those resulting from falls, are virtually unavoidable in the sport of cross country. Due to the constantly changing terrains that cross country runners face, falls and injuries may be a more common aspect of the sport than previously thought. The strenuous nature of the sport and increased injury risk faced by runners are things that make being successful very difficult. Researchers have made connections between joint stability, muscle fatigue, proprioception, and muscle strength and injury/fall rate. Studies have found that balance abilities are lower in fatigued muscles. The frequent injury trends in distance runners show that many of the overused muscles are weak, as well as their proprioceptive abilities. Thus, balance training and strength training could improve strength, decrease fall risk/injury, and possibly improve performance. Addressing these issues could improve balance and muscle strength, and therefore, decrease injuries which could lead to mass improvements to the sport as a whole. Taking a closer look at the balance performance abilities of the cross country athletes at Coastal Carolina University may indicate the need for additional balance and strength training in distance runners as a whole.

Literature Review

Due to the lack of previous research on balance in distance runners, this experiment could potentially lead to great changes in training methods within the running community. Even with the lack of balance research done specifically on runners, there are relatable studies. One very

important study performed by Hyrosomallis examined a possible relationship between balance abilities and the athletic performances of athletes. The author analyzed the balance performance levels of athletes of varying sports and how they compared to each other. This study also compared the balance performance and skill levels of athletes within the same sport (novice to elite). Hrysomallis's main question was to determine whether or not balance abilities have an impact on athletic abilities and performance within different sports. The author concluded that greater balance performance was related to greater athletic performance, leg stability, and strength (Hrysomallis, 2011)

To further elaborate on the topic, Haris et al focused solely on balance performance comparisons amongst football players of different skill levels. The experimenters tested the football players using a Biodex balance system to see if the more elite players had a different balance level than the more novice players; this could reveal if balance was partly responsible for why some players (elite level) are better than the lower level players. The authors theorized that playing football well has a significant requirement of balance; Thus the authors hypothesized that higher level players, would have greater balance performance. Previous research regarding proprioception (the ability to locate one's own limbs) and injury rates helps to back up this claim. This study used one of the most advanced pieces of equipment, the Biodex balance system, and found minimal differences in balance between most of the skill levels of the players (Haris, 2010).

In order to be a successful athlete, proprioception, or being aware of your body, is essential. Proprioceptive abilities may play a role in balance performance and fall history. The main purpose of Blackburn et al's experiment was to establish a possible connection between athletes' proprioception or muscle strength and balance. The researchers wanted to determine

how much of a role strength plays in the stability of a joint, therefore relating to balance after an ankle injury. The researchers separated the subjects into multiple groups with different training plans to test whether the increased muscular strength or proprioceptive abilities improved balance and/or stability levels. The authors suggested that joint stability may be impaired due to an ankle injury, thus strengthening the ankle developing and the proprioceptive abilities should potentially lead to an increase in the stability of the joint and therefore increase balance. Finding a way to increase overall stability could be extremely beneficial to the sports world (Blackburn, 2000).

The main purpose of an experiment performed by Bashiri et al was to analyze the effects of balance training on balance performance. The authors stated that balance training is effective in improving balance performance in the elderly and should be implemented into daily life. The experiment tested 20 elderly male individuals who were divided into one of two groups (control and experimental). Both groups went through balance testing and the experimental group underwent a six-week training program involving various balance exercises. At the end of the six weeks, both groups were tested again. The evidence from this study showed significant differences between the pre-test and post-test balance performance scores. The notable difference in scores suggests that balance training is something that is very important in the elderly to minimize fall risk and therefore risk of injury. This study is one example of how balance training can improve balance performance. This study suggests that athletes may also be able to implement balance training to improve performance and decrease fall risk (Bashiri, 2011).

Balance training is especially important in women. The main purpose of a study performed by Myer et al was to analyze the effects of balance training on female athletes and any improvements on core strength and balance performance. The subjects of this study (female

athletes) underwent 7 weeks of balance training, 3 times per week. The authors had the subjects perform pretest and posttest exercises to analyze changes in deviations in center of gravity during different activities, strengths of different muscles and also jump heights. Previous studies have shown strength improvements from added dynamic stabilization and balance training, helping the athletes strengthen the stabilizer muscles, and leading to a decreased number of injuries and falls. The experiment by Myer et al showed balance and stability training are essential to female athletes (Myer, 2006).

Rozzi et al performed a study that tested the effects of balance training on people who suffered from chronic ankle instability. The researchers separated the subjects into two groups based on whether or not they suffered from chronic ankle instability. They underwent a unilateral (single leg), multilevel 4 week balance training program. This included both static and dynamic exercises. The subjects that were in the chronically unstable ankle group trained only the unstable limb while the other group trained a random limb. After the four week training period, the subjects underwent the same tests as before the training. The results showed that both the subjects with the unstable ankle (experimental group) and the other (control) group both showed balance improvement after the 4 week training period. This shows that balance training does in fact improve balance ability, proprioception, and single leg standing ability, which is very important in runners because the majority of the time spent running, weight is on only one leg (Rozzi 1999).

With all of these different balance training methods, there are countless tests that exist to test balance abilities. The main purpose of a study performed by Sibley et al is to analyze the different assessments that are currently used to test balance abilities. Sibley and his team sent out 1000 questionnaires to patients of physical therapy clinics to determine which types of tests are

the most commonly used. Based on this study, the authors found that the "Single Leg Stance Test", "Berg Balance Scale", and "Timed Up & Go" were used the most frequently. Balance levels are directly linked to fall risk/ history, especially in older individuals, based on previous research. Therefore, having increased balance levels can decrease an elderly individual's fall risk. Research also shows that there are countless ways to measure this, but none shows which is the most prevalent or effective. [Finding which is the most commonly used could relate to the reliability.] With so many different tests in the scientific and clinical realm, this study may help to determine which may be the most valid and reliable (Sibley, 2011).

There are things other than balance training that can influence balance performance. Previous injuries can lead to weakness, even when the injury is supposedly healed. DeVries conducted a study to test the differences in ankle stability in subjects who have had an acute ankle injury versus those who merely have prolonged known ankle instability. The authors hypothesized that due to the disturbed neuromuscular control of an injured ankle, there should be a large difference between the injured and uninjured ankle. They also pointed out that there may be a larger difference between the chronic instability group and the healthy group versus the acute injury group and the healthy group. Previous lower leg injuries could greatly increase an athlete's likelihood of that same acute injury reoccurring. This knowledge could inform coaches and athletes about the major lack of balance and stability training that all athletes need to reduce the risk of injury (DeVries, 2010).

On top of the previous injury factor, fall risk could be increased due to other factors, such as low bone mineral density. In order to determine an individual's fall risk, the main purpose of a study performed by Buatois was to create a scale by using three common clinical balance tests. The authors stated that the "Five Times Sit To Stand" test is one of the most accurate in

determining the risk level of an individual. They state that it is easily determined whether an individual is low, moderate, or high risk for a fall. The three main tests used were the “Five Times Sit To Stand”, “Timed Up and Go”, and the “One-Leg Balance Test”. It is well known that the elderly are at a higher risk of falling due to decreasing bone density, muscle atrophy, and poor equilibrium senses. Knowing where these elderly individuals fall in the risk categories can help determine how much, if any, balance training or therapy is needed to make their lives safer. Researchers were not able to acquire post-test data for a substantial portion of the subjects. [The way low bone mineral density affects fall risk in the elderly could be related to the way that the Female Athlete Triad affects runners] (Buatois, 2010)

Due to the fact that female endurance athletes may face similar bone mineral deficiencies that the elderly do, there may be a possible correlation. The main purpose of an experiment conducted by Pollock et al was to analyze the correlation between bone mineral density (BMD) and exercise training intensity in elite endurance female athletes. Low bone density, one of the components of the Triad, is caused by menstrual dysfunction and disordered eating and was seen in over one third of the athletes that participated in this study. There is quite a bit of research that proves that female athletes of the endurance-sport background are at a significantly higher risk of having a low bone-mineral density. It was also found that 15.9% of the athletes had all three of the components of the Female Athlete Triad. Females, especially of low-body fat sports, such as gymnastics, cross country running, and ice-skating experience heavy pressure to keep their bodies in top shape. This is what leads to the high rate of disordered eating levels, which can cause both menstrual dysfunction and low BMD. These high training levels also take a huge toll on the bodies of these athletes and can amplify the effects of the Triad. The Female Athlete Triad is something that affects countless women (Pollock, 2010)

The low bone mineral density aspect could be a factor in the lack of balance abilities of distance runners, and thus recurring falls runners face many issues due to the strenuous nature of the sport. Tonoli analyzed the common injuries that distance runners face. Running is a very taxing sport on the body, and although it has beneficial effects, there can be some negative ones, too. The authors state that IT Band overuse (Illiotibial Band Syndrome, ITBS), Achillestendinopathy (Inflammation of the Achilles) and Medial Tibial Stress Syndrom, better known as shin splints, are the most common injuries within the distance running community. They also suggest that the majority of runners are not taking necessary precautions to minimize injury levels. Many of the studies show that the presence of an injury makes the future risk of developing another injury much greater. A past injury will also make an individual more susceptible to future injury, even with strengthening exercises. Also, the only studies found on preventive measures include the use of orthoses. These help to compensate for any biomechanical flaws in the runner's form and gait. Distance running leads to countless injuries, many of which could have been prevented, or minimized through stability training. This study is a perfect example of what many running programs are lacking: strength training (Tonoli, 2010).

With all of the common injuries that distance runners face, Goss and Gross analyze different injury patterns and biomechanics in various running styles. The authors argue that different gait patterns or running styles all have different effects on the bodies of runners. Evidence from this study led the authors to conclude that runners with more anterior foot contact, is linked with decreased initial ground reaction forces. This is due to the fact that it leads to a reduced load on the joints, especially of the knees, and is most commonly seen in barefoot runners. The downside to minimalist shoes or running barefoot is the increased risk of stress fractures on the metatarsals. Many of the previous studies that were analyzed in this study were

observational, and did not involve any manipulations of the subjects. The proper type of shoe is essential to optimal performance. Not wearing the right type of shoe could actually cause injuries. By analyzing the biomechanics of different runners, as this study did, the researchers were able to determine if one style may be at a higher risk than another. This information could lead to a change in training, for both the coaches and runners (Goss, Gross, 2012).

Although some authors state that injuries may be due to poor biomechanics, Changela and Selvamani argue that fatigue may be the cause. The main purpose of this study was to determine the relationship between fatigue levels and balance or proprioceptive abilities. Proprioception is the ability to know where one's limbs are in space, and it is very relevant to balance performance. The author states that fatigue is a reduced force-generating ability of a muscle. This can lead to a higher injury rate because the muscles' ability to support the body (balance) has been impaired. Also, injury levels appeared to be much higher later in the workout session, hinting that fatigue may play a role in injury. Injuries are a major setback in all sports, making this study very significant. If coaches are able to minimize a decrease in stability and balance over the course of games and practices, there may be a reduction in injury rates (Changela, Selvamani, 2012).

The same theme is continued in Letafatkar's experiment, with more of a focus on the musculature. The main purpose of this study was to determine if increased fatigue levels have an effect on the balance performance of elite male athletes. The authors argue that the accumulation of lactic acid can lower stability levels, thus decreasing balance abilities. The muscle fatigue caused during exercise is shown to lower the muscular strength and also motor skill performance. Fatigue can cause delays in contraction, and this inability to compensate could lead to poor balance levels. Evidence has shown that muscular fatigue leaves athletes at a higher risk

for injury due to lack of stability and inability to quickly adapt to changes when compared to a non-fatigued athlete. Due to the fact that there are little to no studies existing regarding distance runners, this study can somewhat relate because it analyzes the effects of muscular fatigue on the body (Letafatkar, 2009).

An additional factor that plays a role in fall risk, is age. The main purpose of the study performed by Bird was to analyze the effects of aging on balance orienteering speed and relate it to the effects of years of running on physically challenging terrains. The authors discuss how as athletes age, a substantial decrease should be seen in their orienteering speed. This is widely seen in endurance runners (cross-country and 10,000m track and field competitors). The authors found that men do not show much of a decrease in their orienteering speed as they age, especially when compared to women. Also, after the age of 69, the rate of slowing in orienteering speed was amplified. This led the authors to believe that it could be caused from the years of training on difficult terrain as a distance runner and could have been minimized through frequent strength and resistance training. On top of this, analyzing the different surfaces could show any differences in the runners' reaction times, and thus their ability to prevent falls (Bird, 2001).

Finally, the challenging surfaces that cross country runners face could be the cause of the frequent injuries. The main purpose of a study conducted by Jensen and Karkkainen was to analyze how the body is affected from training in different circumstances. This experiment was performed on both track and cross country runners and VO2 max (or maximal oxygen uptake) and running economy were calculated. Cross country runners, or orienteers train on trails and other challenging terrain, while track runners do most of their training on flat surfaces. The authors argue that if one trains on a more challenging terrain, the body will adapt in the forms of

higher and more efficient oxygen uptake, leading to an overall stronger athlete, in terms of endurance. Previous research has shown that making training more challenging, or using the overload principle, could lead to greater gains in both muscular and pulmonary function. The more difficult training makes the body more efficient and therefore improves the athletes' performance. This study shows how training on challenging surfaces could improve muscular endurance and strength. Based on this, cross- country runners should be relatively stronger than endurance runners who train only on roads or tracks. This higher muscular strength should lead to better balance performance and lower fall rates (Jensen, Karkkainen, 1999).

Endurance runners face many challenges in the sport. From past injuries and falls to the Female Athlete Triad, running can take a large toll on the body, especially in females. The majority of distance runners perform little to no balance and resistance training, despite potential benefits. Researchers have made connections between joint stability (which comes from balance training) and injury/fall rate. Due to the fact that running is such an exhausting sport, causing mass amounts of muscle fatigue, this extra strength training is necessary. Studies have found that balance abilities are lower in fatigued muscles. The frequent injury trends in distance runners, show that many of the overused muscles are weak, as well as their proprioceptive abilities. Balance training has been shown to improve strength and decrease fall risk.

Methods

The purpose of my study was to examine recent fall and injury history and their relationships with balance ability in female Division I Cross Country (CC) runners. Materials needed include a completed informed consent form, health history questionnaire, cone, chair, stopwatch, and Biodex balance system. The population that was tested was the Coastal Carolina

University Division I women's cross country team. All subjects were categorized as "Low Risk" based on ACSM standards.

- Age: 20+/- 2 years
- Body Mass: 51+/- .3 kg
- BMI (Body Mass Index): 20.5+/-1.0 kg/m2

The study began with the subjects completing an informed consent form, along with a health history questionnaire. The questionnaire included information about previous falls, injuries, and fear of falling. The subjects then completed the Timed Up and Go (TUG) and the Five Times Sit to Stand (FTSS) tests, both with shoes on. The subjects next removed their shoes and socks for the second two tests, the Fall Risk (FR) and Limits of Stability (LOS), both of which are on the Biodex balance system. The Biodex has a circular force plate that the subjects stand on and is connected to a computer screen. The stability of the plate can be increased or decreased, making the test more or less challenging. All of the results are computer based, as the system is able to detect even the slightest shifts in weight made by the subject.

Tests:

- Timed "Up and Go" Test (TUG)

The TUG measures the time it takes an individual to stand up from a standard arm chair, walk a distance of 3 meters (~ 10 ft), turn, walk back to the chair and sit down again. Subjects wore their regular footwear and were not provided physical assistance during the test (except to prevent a fall). The participants were scored based on the average time it took to complete two trials.

- Five Times Sit to Stand Test (FTSS)

The FTSS was used to assess leg strength and endurance and began by having subjects sit on the same chair used in the TUG. With their arms folded on their chest, sitting with their back against the chair and feet comfortably placed beneath, they stood up fully and sat down five times as quickly as possible. Timing began when the investigator said “Go” and stopped when the subjects’ buttocks touched the chair on the fifth repetition.

- Biodex Balance Tests

Subject balance was also assessed on two different Biodex Balance System tests in random order: the Fall Risk test and the Limits of Stability test. Both tests required the volunteers to stand on the balance platform and shift their weight to maintain balance while performing computer-based tasks. The volunteers were not allowed to use the hand rails except to prevent a fall. Participants were scored based on an average of two trials for the Limits of Stability (LOS) and three trials for the Fall Risk (FR).

Results:

There was a 100% fall rate amongst the runners within the past year and 87% within the last three months.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std Dev.
Age (Years)	10	18.00	22.00	19.5000	1.17851
Weight (Kg)	10	46.64	55.18	50.8144	3.25192
BMI	10	18.44	22.99	20.5011	1.30734

	N	Minimum	Maximum	Mean	Std Dev.
TUG (sec)	10	4.50	5.26	4.9330	0.29547
FTSTS (sec)	10	4.97	8.43	6.0420	1.25212
Fall Risk Avg	10	0.33	0.70	0.5170	0.10932
LOS (sec)	10	36.50	58.00	48.1500	7.39763
Avg LOS	10	23.00	51.00	37.6500	10.15724

Frequency Statistics

“Do you have a fear of falling?”

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	1	10.0	10.0	10.0
No	9	90.0	90.0	100.0
Total	10	100.0	100.0	

“Have you fallen in the past three months?”

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	6	60.0	60.0	60.0
No	4	40.0	40.0	100.0
Total	10	100.0	100.0	

”Have you fallen in the past year?”

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	10	100.0	100.0	100.0
No	0	0	0	0
Total	10	100.0	100.0	

“If you fell, did you injure yourself?”

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	1	10.0	10.0	10.0
No	9	90.0	90.0	100.0
Total	10	100.0	100.0	

”Any participation injuries related to participation?”

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	8	80.0	80.0	80.0
No	2	20.0	20.0	100.0
Total	10	100.0	100.0	

Correlations

p= .025

Spearman Rho= -0.696

(FTSTS and previous lower extremity injury)

Discussion

After analyzing this data it was found that a surprising 100% of subjects had experienced a fall within the past year. This is a very significant finding because it proves that balance is in fact an issue in female collegiate cross country runners. When the FTSTS and previous lower extremity injury results were correlated it was found that FTSTS test times were slower if the subject had faced a previous injury. Another interesting finding was that even though 100% of

the subjects have fallen within the past year, only 10% admit to having a fear of falling. This could be related to the fact that only 10% actually suffered an injury resulting from the fall. The runners may not know that they have a fear of falling because they have not suffered an injury resulting from it. The runners may not know that balance and fall risk is an issue until after an injury. There was also a very high rate of participation-related injuries faced by these runners (80%). These injuries could indicate overall muscular weakness, which could be the reason for the 100% fall rate of the runners.

This information shows that fall rate, and therefore balance ability, is a great problem in the female runners at Coastal Carolina University. Even though the injury rate in those resulting from falls is low, the actual fall rate is very high. This indicates that high fall rate is in fact an issue that needs attention in the running world.

Although this study was completed to be applied within a sport setting at Coastal Carolina University, the implications of the study can be applied universally across the running community. Whether an individual participates in intercollegiate athletics as a recreational runner the findings of the study can be beneficial to all those involved in the running community. In detail, in order to reduce the risk of harm caused by falls related to the sport of running, it is recommended that all individuals partake in balance training. Since falls are also prevalent to individuals who do not partake in athletics, the same recommendations apply.

Even though this was the first known study of its kind, there are several recommendations that can be made for future research of this nature. The first recommendation that can be made is to expand the sample size of the study. The initial study was composed of ten individuals therefore results could be slightly skewed. In the future, it would also be recommended to examine the manner and frequency in which the individuals fell. For instance,

the running surface that the runner was on when the fall occurred and at what point of time within a run the fall occurred would be two recommendations to further examine. A further recommendation would be to examine runners who train in environments that vary from the ones presented in this study. In closing, these findings show that this is an under exposed topic within the running community. It is hoped that the findings of this study bring to light the dangers associated with balance in runners and lead to future examination of this topic.

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