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Differences in Degree of Dorsiflexion in Varying Base Stances of Collegiate Wrestlers

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Submitted in partial fulfillment of the requirements for
graduation with Honors

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Differences in Degree of Dorsiflexion in Varying Base Stances of Collegiate Wrestlers

Abstract

Lower extremity injuries are very common among wrestlers, especially at a collegiate level. The purpose of this research project was to examine if a difference between dorsiflexion range of motion existed in the talocrural joint between two different wrestling base stances among collegiate wrestlers. The motion measured was active dorsiflexion of the talocrural joint. This motion was measured using a goniometer, an inclinometer, and functional, dynamic balance was assessed using the Y-balance test. A difference in dorsiflexion between these base stances could indicate a higher risk for certain lower body injuries of the knee, foot, and ankle. Wrestling is a high intensity sport with a high risk of injury. Therefore, determining a risk factor that has been associated with increased lower extremity injury risk is useful. Further, if it can be determined that selection of a base stance is associated with increased loss of dorsiflexion range of motion, training could be changed to decrease the athlete's risk for injury. The more that wrestlers and coaches can be educated on this subject, the safer the sport will be. The hypothesis was that there will be a difference between the maximum dorsiflexion that is achieved between the two different groups of wrestlers. Y-balance reach distance will also be significantly different between the two groups. After independent t-tests were completed, there was no significant difference found in ROM or LEYBT measurements between the two base stances.

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Introduction

Anatomy of the Ankle

The talocrural joint is a mortise formed by the articulation between the tibia, fibula, and talus bones. This joint allows for plantarflexion and dorsiflexion of the ankle, with the help of some muscles of the lower leg that dictate the motion of the joint. The primary muscles that are used to actively plantarflex the ankle are the gastrocnemius and the soleus. This pair of muscles contribute over 95% of the strength in plantarflexion. The gastrocnemius and soleus both insert in the ankle via the Achilles tendon onto the posterior surface of the calcaneus (Riegger,1988). In dorsiflexion, the primary muscle that brings the dorsum of the foot closer to the tibia is the tibialis anterior, which originates on the lateral condyle of the tibia and inserts in the ankle at the first metatarsal (Riegger, 1988). These muscles that surround the talocrural joint gives the ankle dynamic stability. Dynamic stability is the stability that is provided by contractile elements such as muscles and tendons. This is important because this stability allows for movement about the joints of the body and without them, joints would be useless. There are also a number of non-contractile elements about the joint that also provide stability. The talocrural joint has bony structures such as the tibia, fibula, and talus that constrict the joint from inversion and eversion. The mortise formed by these bones only allow for dorsiflexion and plantarflexion.

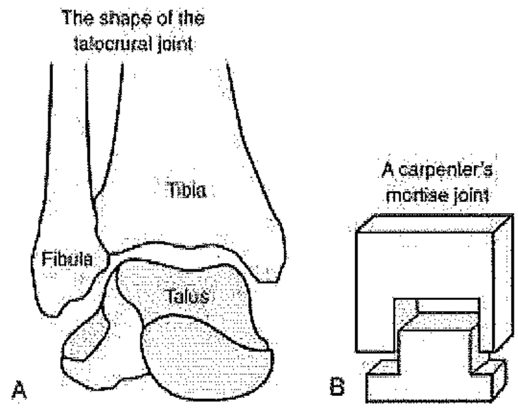


Figure 1 mortise formed by the talocrural joint

Ligamentous structures also add static stability to the talocrural joint. The lateral ligaments of the ankle are numerous and are the ones most susceptible to lateral ankle sprains. The anterior talofibular ligament connects the talus to the fibula. It is tight in plantarflexion and resists inversion of the ankle. The posterior talofibular ligament also originates of the fibula and inserts on the talus. It is tight in dorsiflexion and resists posterior talar displacement. The calcaneal fibular ligament originates on the fibula and inserts on the calcaneus. It is tight in dorsiflexion and limits inversion. The deltoid ligament is located on the medial side of the ankle. The deltoid ligament's deep layers originate on the medial malleolus of the tibia and inserts on the talus. This ligament resists plantarflexion and eversion of the foot and external rotation of the talus (Blomberg, 2016). One final static stabilizer of the ankle is the ankle joint capsule. This capsule seals the joint space and provides stability by limiting motion, primarily dorsiflexion and plantarflexion (Ralpsh, 1994). The ankle joint has two degrees of freedom, meaning it is able to complete motion in two planes, the sagittal and frontal. This allows for a mix of mobility and stability. The ankle is more stable than the shoulder and hip, which have three degrees of freedom and have motion in the sagittal, frontal, and traverse planes. Hinge joints, such as the knee, are more stable than the ankle joint with only one degree of freedom.

Passive insufficiency is defined as the inability of a multi-joint muscle to lengthen to a degree that allows for full range of motion in the direction opposite to the prime motion of the muscle itself. In the lower extremity, the gastrocnemius is subject to passive insufficiency during dorsiflexion of the ankle (Chimenti, Flemister, Tome, Mcmahon, & Houck, 2016). With improper stretching and muscle tightness, the gastrocnemius will not stretch to accommodate full dorsiflexion. In this position, the gastrocnemius can resist the active motion of the anterior tibialis, the agonist muscle for dorsiflexion. Decreased flexibility of the gastrocnemius and soleus can limit dorsiflexion in the open and closed kinetic chain.

Wrestling and Lower Extremity Injury

The vast majority of a standard wrestling match consists of a wrestler in a base position on their hands and knees, with their competitor in a specific position called the referees position. The positioning of the athlete puts weight and stress on the lower extremity, specifically the ankle joint. The base stance usually consists of two variations of the position of the foot and ankle. The normal position places the ankle in a neutral position with the toes extended. The flat ankle position places the ankle in a plantarflexed position with the dorsal side of the foot flat against the mat. With both stances, the motion about the ankle occurs primarily in the talocrural joint.

Wrestling is a high intensity, full contact sport. With this kind of sport, comes many injuries, especially in the knee and ankle. In fact, 32% of wrestling injuries are of the lower extremity

(Jarrett, Orwin, & Dick , 1998). Many of these injuries can be traumatic, meaning there is a specific time and mechanism for the injury. Others can also be from overuse, where the injury is an accumulation of microtrauma over time. The same study details how the rate of injury in wresting compares to other sports and which body parts are most commonly injured. When comparing the injury rate of wrestling to other sports, wrestling was second to only spring football. Over 11 seasons, wrestling had an injury rate of 9.6 injuries per 1000 athlete exposures, which is a total of 8425 injuries. Spring football had the highest injury rate with 9.8 injuries per 1000 exposures. 39% of these wrestling injuries resulted in seven or more days of time loss and 6.3% required surgery. During this study, 42 body parts were injured, and lower body injuries made up a large percentage of the data. The knee was the most commonly injured with 21% of total injuries, followed by ankle at 9% and upper leg at 2% (Jarrett et al., 1998). Individual diagnoses were not named in the study.

Many wrestlers experience injury in practice and even more so in a competition setting. With knee injuries rates, 19% were seen in practice while there was a jump in competition injuries at 26.2%. Ankle injuries in both practice and competition were seen at 8.8%. A study of collegiate wrestling injuries showed a variety of different injuries. These injuries were usually sprains, strains, and contusions (Jarrett et al.,1998). A sprain is an injury to a ligament, which attaches bones to other bones. Ankle sprains are split into three group that are based on severity of the sprain. Grade one ankle sprains are classified by a partial tear or micro tear in the ligament. Grade two ankle sprains are classified by an incomplete tear of the ligament with moderate functional impairment. Finally, grade three ankle sprains are classified by a complete tear and loss of integrity of the ligament (Wolfe , Uhl, & Mcclusky , 2001). Sprains made up 26%

of practice injuries and 33.4% of competition injuries (Jarrett et al, 1998). A strain is an injury to a muscle or tendon, which connects muscle to bone. Strains made up 16.2% of practice injuries and 17.8% of competition injuries (Jarrett et al, 1998). A contusion is a result of a blow to the body that results in the breaking of blood capillaries, otherwise known as a bruise. Contusions made up 6.4% of practice injuries and 6.8% of competition injuries. There was also the occasional cartilaginous tear and traumatic bone fracture in wrestling, but these injuries were only found in competition (Jarrettt et al, 1998).

More recently, another NCAA surveillance data report (Agel, Ransone, Dick, Oppliger, and Marshall, 2007) followed 20% of Division I, II, & III colleges with varsity wrestling teams over the course of 16 years from 1988-2004. The discovery of this study was that lower extremity injures in wrestling made up over 40 % of the total injuries in a match setting and 31.3 % in a practice setting. Of the competition injuries, 7.5 % were of the ankle and 22.9% were of the knee. In practice injuries, 7.3% were of the ankle and 14.8% were of the knee. Even more recently, a similar study was conducted by following 125 participants at a single wrestling team at a Division I institution over nine seasons (2002-2011) (Otero, Graves, & Bollier, 2017). Similar numbers were found in this study of all the different injuries with knee injuries accounting for 17% of the injuries, ankle injuries for 7.7%, and hip injuries accounting for about 2% of all the injuries. An interesting point of this study was that almost 60% of the knee injuries required surgery before return to play. These numbers remained constant from the 1998 study to this 2017 study (Otero, Graves, & Bollier, 2017).

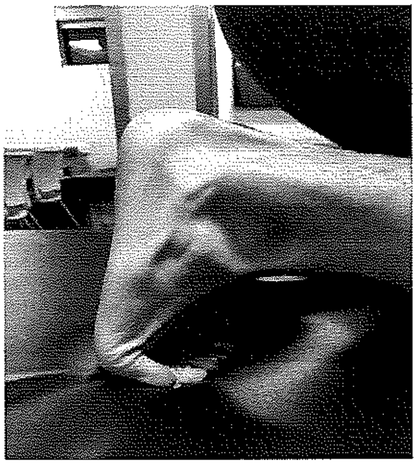


Figure 2- ankle position of the neutral base stance

Figure 3- ankle position of the flat ankle base stance

ROM Loss in the Joints of the Body

Range of motion losses due to repetitive or forceful motions are evident in the joints of the body. Glenohumeral internal rotational deficit, or GIRD, is a range of motion lost by the extreme external rotation forces in throwers (primarily in baseball pitchers). The overhead throwing that pitchers do is recognized as the fastest human movement, with changes in joint angle of 7,250 degrees per second (Wilk et al, 2010). The parameters for GIRD are defined by Burkhart, Morgan, and Kibler (2003) as a loss of internal rotation of 20 degrees or more in the throwing shoulder as compared to the non-throwing shoulder. This rotational deficit is a product of use over time, repetitive motions that are simply part of the sport. In wrestling, athletes can be put into their base stance multiple times in a competition setting, and even more often during practices. This is an integral part of wrestling and is repeated over and over again. Over time, repetitive motions can induce changes in range of motion in joints of the body. No studies, to date, have linked the connection of the base stance in wrestling to changes in talocrural range of motion in the same way that overhead throwing has been to causing GIRD.

Intrinsic and Extrinsic Risk Factors for Injury

Previous studies have identified factors associated with increased ankle injury risk in athletes. One of those factors is range of motion. A systematic review by Murphy, Connolly, and Beynnon (2003) investigated many intrinsic factors that affect injury risk in athletes, one of those being range of motion. In soccer players, there was an increased risk of knee hyperextension and overuse ankle injuries associated with athletes who had had decreased ankle dorsiflexion ROM and decreased hamstring flexibility (Söderman, Alfredson, Pietilä, & Werner, 2001). In military training, there was an increased risk of Achilles tendonitis due to increased active inversion (Kaufman, Brodine, Shaffer, Johnson, & Cullison, 1999). Increased inversion was also associated with lateral ankle sprains. Finally, in field hockey and lacrosse, there was an increased injury rate associated to eversion range of motion. Increased ankle active eversion was associated with injuries such as eversion ankle sprains and plantar fasciitis (Beynnon, Renström, Alosa, Baumhauer, & Vacek, 2001). Another study by Fong et. al (2009) stated that in males, intrinsic factors such as slower running speeds, less cardiorespiratory endurance, decreased dorsiflexion strength, decreased dorsiflexion range of motion, and faster reaction times of the anterior tibialis were all risk factors for inversion ankle sprains.

Along with these intrinsic risk factors for ankle injury, extrinsic risk factors also exist. Extrinsic factors for injury are factors that come from an outside source rather than within the joint itself. One risk factor that applies greatly to wrestling is level of competition. A study by

Myers, Linako, Mello, & Linakis (2009) followed injuries of 152,710 wrestlers in the United states over 6 years in a competition setting. This study found that wrestlers from the age of 12-17 years old had an injury rate of 29.57/1000 injuries in competition with 25% of the injuries being of the lower extremity. Another study (Newton et al., 2009) looked at the relationship between the coefficient of friction and playing surface and its implication for wrestling injury. The researchers compared the friction of an old and new wrestling mat with new and worn wrestling shoes. The researchers found that with new shoes and a new mat, the friction coefficient was 28% higher than any other combination. These findings infer a potential to increase knee and ankle injury risk by fixing the foot more securely to the ground.

Injuries Related to Loss of Dorsiflexion ROM

Studies have related a multitude of injuries to deficits in dorsiflexion range of motion, the main measure for this study. Plantar fasciitis is a chronic injury that is characterized by inflammation of the plantar fascia on the dorsal portion of the foot. The plantar fascia prevents arch collapse on the foot by providing tensile strength between the calcaneus and metatarsals. The plantar fascia utilizes the windlass effect, a mechanism of keeping the arch of the foot from collapsing during the propulsive phase of gait. This occurs because the plantar fascia raises the medial longitudinal arch of the foot by bringing the calcaneus and metatarsals closer together (Bolgla & Malone, 2004). This study on plantar fasciitis treatment found a correlation between dorsiflexion deficits and plantar fasciitis. According to Bolgla and Malone (2004), "persons with a flexible foot type can compensate for this lack of ankle dorsiflexion by unlocking the midtarsal joint because dorsiflexion and abduction are movements allowed at the midtarsal joint's oblique axis. This increased motion results in excessive pronation that can stress the plantar fascia" (Bolga & Malone, 2004, p. 79). This deficit in dorsiflexion can cause plantar fasciitis in certain individuals.

Medial tibial stress syndrome (MTSS), commonly known as shin splints, is a chronic overuse injury that is classified by an inflammation periosteum along the posterior medial tibial border (Shultz, Houglum, & Perrin, 2016). MTSS has a plethora of risk factors including footwear, training on uneven surfaces, and gender. A study by Yates and White in 2004 also identified lack of dorsiflexion as an important risk factor for MTSS. The study was conducted with 124 naval recruits going through ten weeks of basic training and showed that recruits with less dorsiflexion range of motion developed shin splints during their training. The data in this study was measured with a standard goniometer with the subject's knee extended and at 90 degrees of flexion. Active dorsiflexion range of motion measurements were taken in this study. This is a result of the dorsiflexion deficit causing an excessive subtalar joint pronation which is another subsequent risk factor for MTSS.

Achilles tendonitis is a chronic overuse injury that is caused by intense strain on the Achilles tendon the tendon that connects the gastrocnemius to the calcaneus. A 2014 study by Rabin, Kozol, and Firestone examined 70 army recruits and measured their non-weight bearing ankle dorsiflexion before and after their 26-week basic training the active dorsiflexion ROM was determined by using a standard goniometer with the subject laying prone and their knee flexed to 90 degrees. it was determined that those that developed Achilles tendonitis (5 subjects) had a lack of dorsiflexion in the injured leg in the preliminary measuring. This study shows that a lack of dorsiflexion can cause an individual going through intense physical training is at an increased risk of developing Achilles tendonitis.

The importance of dorsiflexion in gait has been studied for many years. The gait cycle consists of two main phases, stance and swing. The stance phase is further split into five subsequent phases, heel strike, foot flat, midstance, heel off, and toe off. Dorsiflexion is very important as the ankle must dorsiflex ten degrees at midstance (Shultz et al, 2016). Problems arise if there is a dorsiflexion deficit during this phase. According to a 2013 study by Dudziński, Mulsson, & Cabak, they determined that ankle dorsiflexion deficits effected other aspects of gait, specifically knee extension. Seventeen patients who had recently had ankle fracture surgery had their knee extension range of motion tested. There was significant evidence to declare that a restriction in ankle dorsiflexion can cause hyperextension of the knee during the midstance phase of gait. This is important because a mechanism for anterior cruciate ligament sprain is when the knee is in full extension and the athlete or individual is cutting or changing directions quickly (Shultz et al, 2016) This is very prevalent and common position for a wrestler to be in during a match or practice setting, where they are planting their foot and changing directions quickly.

Ankle sprains are very prominent in the athletic world. A lateral ankle sprain consists of overstretching of either the anterior talofibular ligament or calcaneofibular ligament. The most common mechanism for this injury is landing on the foot with the ankle in a plantarflexed and inverted position (Shultz et al, 2010). There has been found to be a correlation between ankle dorsiflexion range of motion deficits and the risk of ankle sprains. A 2005 study by Willems, Witvrouw, Delbaere, Mahieu, Bourdeaudhuij, and Clercq found many different intrinsic factors for ankle injuries, one of which was range of motion. Two hundred and forty-one male subjects underwent goniometric testing for ankle dorsiflexion with the knee straight and with the knee flexed. The subjects were then followed for one to three years. The results of this study concluded that decreased dorsiflexion range of motion can be considered a predictive risk factor for ankle sprains.

Methods of Measuring Dorsiflexion

To measure ankle dorsiflexion, a researcher can use many different tools. One of the simplest tools is a goniometer, which is a plastic tool that measures joint angle. The reliability of this instrument has been tested and researched for many years. It is well known that measurements taken by an experienced therapist are more accurate than an inexperienced therapist. A study by Youdas, Bogard, and Suman in 1993 tested the intra-rater and interrater reliability of goniometry by taking active range of motion measurements for ankle dorsiflexion and plantarflexion of 38 patients. The measurements were taken in the open kinetic chain with the knee at either 90 or 0 degrees of flexion, depending on patient preference. Intra-rater reliability refers to the ability of one tester to be to have agreeing repeated measurements on one patient. Inter-rater reliability refers to the ability of multiple researchers or testers to have agreeing data after administrating a diagnostic test such as goniometric measurements. There was found to be a high intra-rater reliability, with intraclass correlation coefficients of .64-.92 in active dorsiflexion and .47-.96 in ankle plantarflexion. Inter-rater reliability was low with interclass correlation coefficients of .28 for dorsiflexion and .25 for plantarflexion. Thus, there is high intra-rater reliability and low inter-rater reliability with goniometry for dorsiflexion.

Another way to assess ankle dorsiflexion active range of motion is to conduct a kneeling, closed kinetic chain dorsiflexion test. The measurement tool used for this is called a digital inclinometer, which measure surface inclination in degrees. This is slightly different from a goniometer as its positioning does not depend as much on anatomical reference for placement as the goniometer does. A 2012 study by Santos et al, tested the inter- and intra-tester reliability between a goniometer and digital inclinometer by measuring active knee and elbow flexion/extension range of motion in ten healthy males between 18-30 years of age. The results of the study showed that there is high intra-tester reliability with a range of .84-.97 ICC and high inter-tester reliability with a range of .69-.98 ICC. This confirms that a digital inclinometer is a very reliable and valid source of measurement for recording ankle dorsiflexion.

Another test that has been used frequently in screening assessments for lower extremity injury risk is the Lower Extremity Y-Balance Test (LEYBT). The LEYBT is used to assess dynamic balance, as it asks participants to stand on one limb and reach with the other limb in the anterior, posterolateral and posteromedial directions. Differences or deficits in these reach directions have been found to be correlated with increased lower extremity injury risk. A study by Gonell, Romero, and Soler (2015) studied 74 professional soccer players by using the LEYBT prior to their 2011 season. In this study, anterior, posteromedial, and posterolateral reach distances were measured, as were the limb lengths of the players. The athlete's athletic trainers then documented how many days the players were unable to play after injury. For the purposes of this study, an injury was defined as an event that caused at least one training day to be missed. Regression models of this study showed that a difference of greater than 4 cm in the posteromedial directions between the lower limbs were almost four times more likely to suffer a lower extremity injury. Another result of this study concluded that athletes with reach scores lower than the mean in any reach direction were two times more likely to sustain an injury.

A study by Kang et al (2015) showed that the best single predictor of reach distance in the anterior direction is ankle dorsiflexion angle. This factor accounted for 65% of the variance in the anterior reach distance. Therefore, a lower anterior reach can be attributed to decreased stance foot dorsiflexion range of motion by in large. Another study measured the reliability of using the Y-balance test. The researcher in this study conducted the test with 15 male collegiate soccer players and calculated intraclass correlation coefficients (ICC) to determine reliability of the LEYBT. According to Plisky Et al (2009), the intra-tester reliability ranged from .85-.91 and an inter-tester reliability of .99-1.0. The research showed that the lower extremity Y-balance test has excellent reliability for testing the lower body.

The purpose of this study was to determine if a difference in dorsiflexion range of motion exists between the two different base stances stated. If a particular base stance is associated with a loss in dorsiflexion ROM, those athletes may be a risk for lower extremity injury. Significantly different goniometric, CKC dorsiflexion and LEYBT reach distances could offer insight for one stance preventing injury over the other.

Methodology

This research was conducted on Division III collegiate wrestlers at Otterbein University. The study was approved by the Otterbein institutional review board. The subjects were recruited from the Otterbein University wrestling team. Subjects could not have sustained any ankle injuries within the past year. The subjects signed a consent form prior to any data collection. To begin data collection, each participant sat on an examination table with their ankle slightly off the table and knee extended. Subject's dorsiflexion was measured bilaterally with a goniometer. An experienced researcher placed a standard goniometer at the appropriate landmarks and the participant actively dorsiflexed the foot and active dorsiflexion ROM was recorded. This was completed bilaterally with each participant. The subjects also completed a closed kinetic chain dorsiflexion test. Subjects placed the ankle being measured on a line of tape on the floor with the 2nd toe and middle calcaneus centered on the tape. The subject was then instructed to get into a lunging position with the ankle being measured in a neutral position at zero degrees. A rater used an inclinometer app on a smartphone and placed the phone border flat against the tibial tuberosity. The participant was then instructed to lean as far forward as they could without allowing their calcaneus to come off the ground. The subject was instructed to stop at end range or to return the calcaneus to the tape if lifted off. A second rater then recorded the degrees of dorsiflexion obtained once the first rater had determined end range of motion. This measurement was taken three times bilaterally.

Finally, the subjects completed the LEYBT. This method used a Y-balance testing kit with posterior arms 135 degrees from the anterior arm and 45 degrees between the posterior arms. The protocol for lower extremity Y-balance testing was as follows: subjects stood with one leg on the center foot plate with the edge of their shoe on the starting line. While keeping this single leg stance, the subject pushed the foot plate in the anterior, posteromedial and posterolateral directions. Subjects were given three trial runs followed by 3 recorded runs on each leg. Recorded values were taken based on markings on the Y-balance kit arms. The trial was considered a failure If the subject did not maintain the single leg stance (falling off of the central foot plate), maintain contact with the reach foot plate, used the reach foot plate for stance support, or failed to return the reach foot to the starting position (Walker, 2019).

Results

Study participants included 18 male, Division III wrestlers. After the data was collected, independent t-tests were conducted to determine if there was a difference in the mean values for open kinetic chain dorsiflexion between the wrestlers who elected a given base stance. Right and left limb comparisons were completed for each subject. The independent t-tests were repeated for the closed kinetic chain dorsiflexion measures and between each reach direction of the LEYBT. An alpha level of .05 was established for all analyses. Group one (neutral ankle stance) consisted of 8 athletes and group 2 (flat ankle stance) consisted of 10 athletes for a total of 18 subjects. To have significant differences between these stance, p-values needed to have a p-values of less than .05. In the open kinetic chain, the left extremity had a mean of value of 6.63±4.41 in the neutral ankle stance and 6.8±3.04 in the flat ankle stance, resulting in a p-value of .922. In the right extremity, the mean value was 7.75±3.32 in the neutral stance and 7.5±3.31 in the flat ankle stance, resulting in a p-value of.876. The mean values for the left closed kinetic chain were 40.1±9.6 in the neutral stance and 41.54±5.78 in the flat ankle stance, giving a p-value of .699. In the right extremity, mean values were 49.02±19.51 and 41.71±4.8 in the neutral and flat stance, respectively. This resulted in a p-value of .267 (Table 1).

The other measurements that were taken were from the LEYBT. The measurements for this test were taken three times, then the highest value was recorded for each direction and for each limb. For the anterior direction of the LEYBT, left extremity mean value was 56.88±5.87 in the neutral stance and 58.0±4.11 in the flat ankle stance. This resulted in a p-value of .639. The right extremity also had similar values. The neutral ankle base stance had a mean value of 58.13±7.38 and the flat ankle stance had a mean of 57.7±4.35, giving a p-value of .881. The posteromedial directions had a p-value of .266 in the left extremity and .324 in the right extremity. The posteromedial p-values were .968 in the left limb and .509 in the right limb (Table 1).

Group	OKC Left	OKC Right	CKC Left	CKC Right	Left Ant	Right Ant	Left PM	Right PM	Left PL	Right PL
1-neutral stance	6.63±4.41	7.75±3.32	40.1±9.6	49.02±19.51	56.88±5.87	58.13±7.38	102.8±6.73	102.63±10.23	96.13±10.47	93±13.27
2- flat stance	6.8±3.04	7.5±3.31	41.54±5.78	41.71±4.8	58±4.11	57.7±4.35	95.7±16.45	96.2±15.29	95.9±12.22	96.8±10.63
p-value	0.922	0.876	0.699	0.267	0.639	0.881	0.266	0.324	0.968	0.509

Table 1- Independent T-Test at 95% Confidence (N=18) of Bilateral Measurements in the OKC, CKC, and LEYBT. Ant: Anterior, PM: Posteromedial, PL: Posterolateral

Discussion

Losses in range of motion in joints over time are seen in joints like the shoulder in the form of GIRD and have been documented by researchers like Wilk et al (2011) and Burkhart et al (2003). Range of motion can be lost over time from repetitive and forceful motions such as overhead throwing, but limited research has concluded if the same holds true in joints like the ankle. As a sport, wrestling has one of the highest injury rates in the lower extremity among sports. Surveillance data by Jarrett et al (1998), Agel et al (2007), and Otero et al (2017) report injuries of the knee, ankle and hip account for about 40 percent of all injuries that a wrestler has in a season. This study examined if the particular base stance selected by a wrestler would result in a significant difference in dorsiflexion range of motion. Deficits in dorsiflexion range of motion have been found to result in increased risk for injuries such as plantar fasciitis (Bolgla & Malone, 2004), medial tibial stress syndrome, Achilles tendonitis (Rabin et al, 2014), changes in gait (Dudziński et al, 2013), and lateral ankle sprains (Willems et al 2005).

No previous studies have examined the effect that a particular base stance might have on range of motion in the ankles of collegiate wrestlers. Rather, many researchers investigated extrinsic and intrinsic factors that may predispose athletes to injury, but none of those studies have been specific to wrestling. A text written by Shultz et al (2016) reports musculoskeletal injury and what it is caused by. Another study by Baumnhauer et al (1995) examined multiple risk factor like joint laxity and isokinetic strength to determine if a relationship existed between them and ankle injury. Other researchers assessed extrinsic factors such as the relationship between coefficient of friction between wrestling mat and shoes and its potential to increase injury (Newton et al, 2002). The results of this study do not support that a preferred base stance position in wrestling resulted in a difference in dorsiflexion range of motion between base stance groups. Base stance groups were not significantly different for reach distances on any direction on the LEYBT. These results indicate that wrestlers who choose a particular base stance are not at risk for developing a loss of dorsiflexion ROM or a loss of LEYBT reach distance as compared to those that elect a different base stance. No one stance results in a higher risk for lower extremity injury. This allows athletes and coaches to not worry about using one stance over another for an extended time and wrestlers can freely favor a stance without risk of lower extremity injury.

There were a few limitations to this study. One limitation would be that the sample size was small. A larger sample size would more closely approximate the population of collegiate wrestlers and there would be a greater chance for determining a significant difference. Another limitation to this study lacked follow up data to determine loss of range of motion over time. The study would have benefited from range of motion and LEYBT measurement over the course of this individual season or even a longitudinal study, rather than just a one-time measurement. In addition, normal LEYBT protocol requires researchers to take a composite score for each participant. This is done by taking the sum of the three reach distances and dividing that by 3 times the limb length (Walker, 2019). This method gives a normalized measurement across all participants, regardless of limb length. This was not done in this study, only the furthest reach distance was measured and used for the independent t-tests. Another limitation is that researchers did not have access to medical history to know if an athlete has had an ankle injury in the past.

To expand on this study, future studies should work to include other positions and stances that wrestlers are in during a standard match. This could include their neutral stance that can vary greatly between individuals, or even the way that an athlete could tie up with an opponent in the neutral stance. All of these have many variations and could influence an athlete's range of motion in the lower extremities. Further studies should use a longitudinal design to determine if a change in range of motion occurs over the course of multiple seasons. Finally, further studies on this subject should use the composite scores for the LEYBT, rather than a max reach distance.

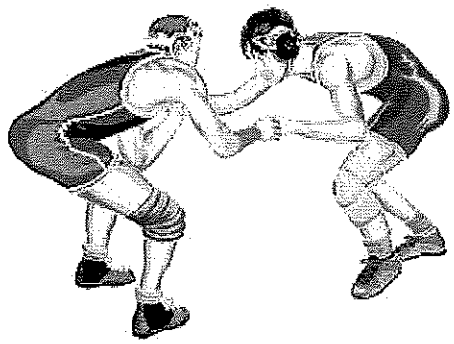


Figure 4- example of a neutral stance

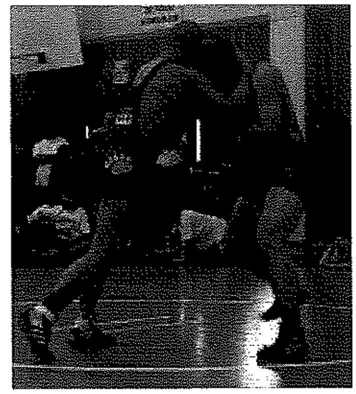


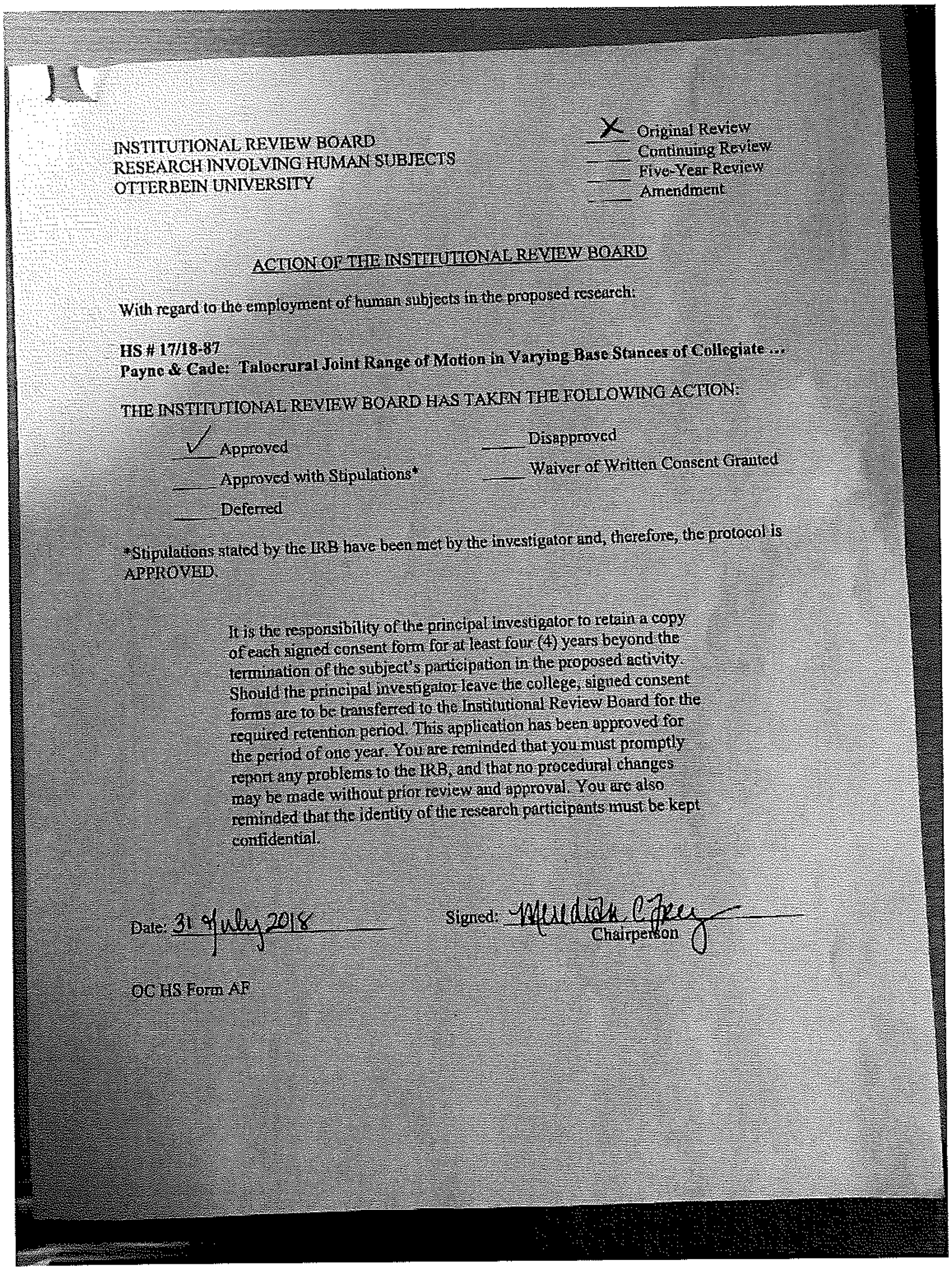
Figure 5 - example of a tie up stance

Conclusion

In conclusion, the hypothesis of the study is not supported by the result presented. A difference in ankle ROM between base stances in collegiate wrestlers does not exist. Even though there were no statistical differences between the stances, further studies can be done to examine the ROM in the ankles of wrestlers in different positions. The neutral standing stance and tie up stances could also be examined to determine ROM difference. These studies would benefit from having a longitudinal design study to take multiple measurements in a season, or even throughout multiple seasons. This would be a greater indicator of ROM change and loss of dorsiflexion ROM.

Appendix A

Institutional Review Board Approval



INSTITUTIONAL REVIEW BOARD
RESEARCH INVOLVING HUMAN SUBJECTS
OTTERBEIN UNIVERSITY

X Original Review
___ Continuing Review
___ Five-Year Review
___ Amendment

ACTION OF THE INSTITUTIONAL REVIEW BOARD

With regard to the employment of human subjects in the proposed research:

HS # 17/18-87
Payne & Cade: Talocrural Joint Range of Motion in Varying Base Stances of Collegiate ...

THE INSTITUTIONAL REVIEW BOARD HAS TAKEN THE FOLLOWING ACTION:

✓ Approved
___ Approved with Stipulations*
___ Deferred
___ Disapproved
___ Waiver of Written Consent Granted

*Stipulations stated by the IRB have been met by the investigator and, therefore, the protocol is APPROVED.

It is the responsibility of the principal investigator to retain a copy of each signed consent form for at least four (4) years beyond the termination of the subject's participation in the proposed activity. Should the principal investigator leave the college, signed consent forms are to be transferred to the Institutional Review Board for the required retention period. This application has been approved for the period of one year. You are reminded that you must promptly report any problems to the IRB, and that no procedural changes may be made without prior review and approval. You are also reminded that the identity of the research participants must be kept confidential.

Date: 31 July 2018

Signed: __________
Chairperson

OC HS Form AF

Appendix B

Data collection sheet   Base Stance Type:

Open kinetic chain dorsiflexion (in degrees)

Left	Right

Closed kinetic chain dorsiflexion (in degrees)

	Left	Right
1		
2		
3		

LEYBT

	Left Anterior	Left Posteromedial	Left Posterolateral
1			
2			
3			

	Right Anterior	Right Posteromedial	Right Posterolateral
1			
2			
3			

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