COMPARISON OF FUNCTIONAL AND COMPENSATED TURNOUT IN BALLET AND JAZZ DANCERS

by

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A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Science
with a Major in Athletic Training
May 2020

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ACKNOWLEDGEMENTS

I would like to thank my family who has supported me throughout this entire process. I would also like to thank Dr. James Farnsworth for his guidance and skilled knowledge that assisted me in completing this research.

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ABSTRACT

Poor turnout technique and compensation are two of the main causes of lower extremity injuries in dancers. Most of the research investigating the effects of compensation on injury risk is limited to ballet dancers which may not generalize to all dance styles. **Purpose:** To compare external hip rotation during functional and compensated turnout in ballet and jazz dancers, examine the relationship between compensated turnout and injury history, and determine the compensatory motions most frequently used during compensated turnout. **Methods:** External hip rotation during functional and compensated turnout was evaluated in female ballet, jazz, and non-dancers recruited from the university and several dance studios. All participants completed a brief demographic questionnaire containing questions about age, height, weight, dance style, years of experience, and injury history. A 3 x 2 repeated measures ANOVA was used to evaluate differences in external hip rotation during turnout. Correlation analysis was used to examine the relationship between degree of compensation and injury history. Snapshot photographs were taken of the lower extremity of all participants performing turnout to determine compensatory motions most commonly used. **Results:** Ballet dancers had significantly higher external hip rotation compared to jazz and non-dancers during both functional ($p<.01$) and compensated turnout ($p<.01$) In addition, both ballet and jazz dancers had significantly higher external hip rotation during compensated turnout compared to functional turnout ($p<.05$); however, no differences were found in non-dancers ($p>.05$). No relationship was found between injury history and degree of compensation ($p>.05$). The most common compensatory mechanisms were genu

recurvatum, anterior pelvic tilt, and flat back. **Conclusion:** Both ballet and jazz dancers used compensatory motions to increase external hip rotation during turnout. The degree of compensation and range of motion varied across dance styles indicating that research on one group may not be relevant to all dance styles. Although no relationship was found between turnout and injury rate, which contradicts current research, results may have varied from differences in sample size and measurement technique.

I. INTRODUCTION

Dance is expressive movement executed in many forms including artistic, cultural, and competitive sport. Some artistic dance styles like ballet and jazz require considerable physical skill and fitness containing impeccable balance, precise muscular control, strength, rhythm, and speed.[1] When performing such graceful and dynamic movements, ballet and jazz dancers also place their joints in extreme positions relative to typical human range of motion, which look effortless to the audience. Skilled dancers master unique and inversely related physical demands of joint hypermobility and strength, potentially contributing to injury.

Injury prevalence in dancers ranges from 42-95%, across multiple genres and levels, including pre-professional and professional.[2] Due to the repetitive movements required during ballet and jazz dance practice and performances, overuse injuries make up the majority of dance-related injuries, with most occurring at the foot[3-6]and ankle.[3-7] Training errors and biomechanical imbalances due to technique faults are hypothesized to be the mechanism of most dance injuries.[8,9] Poor turnout technique and compensation are two of the main causes for lower extremity injury.[2,5,8]

Turnout is a dance term defined as external rotation of the dancer's legs and feet, with the feet rotated 180^{o} (90^{o} external rotation of each hip to equal 180^{o} away from each other) along the longitudinal axis.[8] Proper functional turnout, the true amount of uncompensated hip external rotation, requires strength, flexibility, and neural activation patterns at the hip.[10] The majority of dancers do not have the natural 180^{o} rotation and achieve this position through compensatory motions. Compensated turnout mechanisms can be seen with anterior pelvic tilt and lumbar lordosis which creates a pattern of pronated feet, hyperextended knees, and forcing the rib cage to extend forward, and is

overall correlated with a high injury risk.[8,10] By externally rotating the entire lower extremity farther, the demand of the standard 180° turnout can be achieved.

Differences between ballet and jazz styles can be seen in the muscular demands, anatomical body types, and specific choreography which suggests that research on one style may not necessarily apply to all dance styles.[11] In ballet the extreme 180° of turnout is critical for standards in this dance discipline, however other styles, like jazz, require transition between parallel, feet apart at the distance of the center of the hip sockets, with toes facing forward, and turnout foot positions.[5] Dancers use turnout frequently when moving through the five basic ballet positions for the feet,[8] and is a key element during many technical movements. Few other activities and sports require the maximum external hip rotation like ballet does, it is a unique requirement but one of the most important.[10] Dancers from different styles of training may not have the same turnout function and tolerance for hip external rotation.[5] The majority of research investigating effects of compensation on injury risk is limited to ballet dancers which may not generalize to jazz dancers. Therefore, the purpose of this study was to compare external hip rotation during functional and compensated turnout in ballet and jazz dancers, examine the relationship between compensated turnout and injury history, as well as the most common compensatory motions frequently used during compensated turnout.

Research Questions

The research questions guiding this study are:

1. Is there is difference in external hip rotation during functional and compensated turnout among ballet, jazz, and non-dancers?
2. Is there a relationship between compensated turnout and injury history in ballet and jazz dancers?

3. What are the compensatory motions most frequently used during compensated turnout?

Hypothesis

1. There will be a difference in external hip rotation during functional and compensated turnout among ballet, jazz, and non-dancers.
2. Dancers with a higher degree of compensated turnout will have a greater injury history.

Independent Variable(s)

1. Dance Style (e.g., Ballet, Jazz, Non-dancer)

Dependent Variables(s)

1. Functional turnout (measured in degrees).
2. Compensated turnout (measured in degrees).
3. Injury history of dancer-related injuries from performing arts career. Injury is defined as: a physical complaint that occurred from dancing, that was caused from performance, rehearsal, or class.

Assumptions

1. All questions answered on the injury history form will be answered thoroughly and truthfully.
2. All participants will give maximum effort during measurement of their turnout.

Limitations

1. This study is limited to the recall bias of past injury history.
2. Participants may vary in levels of ballet and jazz dance training.

Delimitations

1. The generalizability of this study may be limited due to the cross-sectional and retrospective design.
2. The focus of this study is only ballet and jazz dance styles.
3. The results of this study are generalized to 18 years and over population, however a large majority of dancers are under 18.

Definition of Terms

There are five basic ballet positions for the feet[12] 1) *First position:* legs are externally rotated and heels are together 2) *Second position:* legs are externally rotated and feet are separated past shoulder width in the frontal plane 3) *Third position:* legs are externally rotated, one foot in front of the other, halfway between each, and facing away 4) *Fourth position:* legs are externally rotated, one foot crossed in front of the other, separated by the distance of one foot 5) *Fifth position:* legs are externally rotated, one foot crossed in front of the other, forward toe touching back heel.

Turnout. The external rotation of the dancer's hips, legs, and feet. The ideal bilateral lower extremity measurement is 180^{o} away from each other on the longitudinal axis with each foot aligned on the frontal anatomical plane.

Parallel Position. Feet side by side or wide, apart at the distance of the center of the hip sockets, with toes facing forward.

Functional turnout. The angle created in all 5 ballet positions and is the true amount of uncompensated hip external rotation

Compensated turnout. The difference between functional turnout angle and total (left plus right) hip external rotation range of motion.

Ballet dance: A style of dance in which controlled movements of the body are designed to express the beauty of physical motion, often while telling a story, or a piece of music. It is based on an elaborate formal technique which entails grace, precision, and fluidity.

Jazz dance: An umbrella term that encompasses multiple genres of tap, ballet, and African American rhythms that contains clean and strong lines emanating from the hips and chest.

Non-dancer: An individual who does not have any background in dance or previous dance training.

Specific Aims

[1] To determine if there are differences in external hip rotation during functional and compensated turnout between ballet, jazz, and non-dancers.

[2] To examine the relationship between compensated turnout and injury history in ballet and jazz dancers.

[3] To determine the compensatory motions most frequently used during compensated turnout.

II. LITERATURE REVIEW

This chapter provides a review of the literature for the proposed research. Information is included regarding dance, physical demands of ballet and jazz styles, injuries in ballet and jazz, turnout and lower extremity injures.

Dance

Dance styles like ballet and jazz require considerable physical skill and fitness containing impeccable balance, precise muscular control, strength, rhythm, and speed.[1] When performing such graceful and dynamic movements, ballet and jazz dancers place joints in extreme positions relative to typical human range of motion, which look effortless to the audience. Skilled dancers master unique and inversely related physical demands of joint hypermobility and strength, potentially contributing to injury.

A large component of dance that differentiates it from any other sport includes the pressure that dancers put on their individual bodies; both mentally and physically. Dancers create the beautiful illusion of effortless technique and performance by creating motions with their limbs, combined with the preparation in their spine and a strong core.[13] The end product is the dancer's ability to express a universal language without using any words.

Dancers Unique Mentality

Dancers, and performing artists in general, are often misunderstood by medical professionals. Among university dancers, 80% reported that healthcare providers do not fully comprehend the magnitude of performing arts, and 43% reported that although they received medical care, they believed it to be inadequate.[2] These misunderstandings often lead to dancers neglecting to seek professional medical care when injured. Krasnow, Mainwaring, and Kerr[14] reported that only 58% of ballet dancers sought treatment from a

physical therapist, and only 19% consulted physicians following injury. This is concerning for when dancers prolong seeking treatment, the severity of the injury increases, and may have negative effects on the individual's overall health.

Collegiate dancers will rarely seek out guidance from a physician.[15] Over a 6 month period 25 dancers had 55 injuries, and only 6 of those injures were evaluated by a physician. Dancers saw the instructors as the first option for treatment, physical therapist was second, and physician was third.[15] Dancers truly believe they are misunderstood as performing artists in all aspects ranging from terminology, technique, and consistently receive the advice to "stop dancing".[15] Dancers are reluctant to come forward with an injury and are expected to push through aches and pains, grinding through discomfort barriers, to improve their performance.[16] The performing arts culture has created the concept that dancers must fight through to maintain their fitness, technique, position and "the show must go on".[16] It is important to these unique athletes that the medical care they receive comes from a small amount of dance knowledge.[15] This includes the ability to describe mechanism, movements, and the factors that play into their sport.

Demands Placed on Dancers

Dancers have intense schedules between practice, performance, rehearsals, weight training, and conditioning.[17] Dancers can practice up to 34 hours a week,[18] and in the professional realm a typical workday can be 9.5-18.5 hours.[19] A dancer can spend 90 minutes in class, then be in rehearsal for the remainder of the day.[20] Those in higher rankings have been shown to have less than half a minute of a break above resting intensity, and less than 20 minutes for the entire day.[20] It is well known that dancers will work through any type of fatigue and injury, and admit to "dancing through" pain.[2,19] Dancers are expected to remain dedicated and persevere through pain to become a master

of the dance craft.[21] They have immense pressure to perform at a consistent high level, or risk losing their position for missed rehearsals and performances.[21,22] The majority of dancers retire at 34 because of health concerns, while 30 is considered the "turning point" due to biological and cultural pressure to retire.[15]

Pain Management

Dancers are notorious for short careers,[7] and typically have no "off season".[2] The concept of perfectionism carries a strong relationship with injury patterns.[14] Therefore, dancers will ice, wrap, tape, brace, and medicate to persevere through a season.[19] If not, it can be perceived as a lack of physical or mental commitment from peers and instructors.[19] Studies show dancers will experience symptoms for a longer period of time before seeking help[19,23] Majority of injuries could be treated with conservative care,[7] however the misunderstood dancers feel will delay treatment, and as such, is linked with persistent suffering.[21] It is better to prevent or treat the injury than remove the dancer from performing, because they will ignore the advice regardless.

Dancers have a higher pain tolerance and pain threshold than non-dancers.[2] Their concept between what is normal pain for performance, and what is true injury pain, differs from other sports.[2,23] Since dancers will typically not follow medical advice, this is turn generates an internal struggle of taking time off or having technique modified.[16] If not they risk creating a more detrimental injury.[16]

Epidemiology of Dance Injuries

Dancers train every segment of the body; from the upper neck, to the wrists, all the way down to the toes. This combined with rigorous training schedules creates a unique assortment of injuries which stems from constant repetitive movements at multiple joints.

Prevalence and Incidence

There are high injury rates among elite adolescent and professional dancers.[24] At the New York City Ballet, 17% of dancers are not practicing or performing due to injury.[8] Injury prevalence in dancers ranges from 42-95%, across multiple genres and levels, including pre-professional and professional.[2] Due to the constant repetitive movements required during ballet and jazz dance practice and performances, overuse injuries make up the majority of dance-related injuries, with most occurring at the foot[3-6]and ankle.[3-7]

Types of Injuries

Lower extremity injuries are the highest in the performing arts with 29% occurring at the knee, 25% ankle, 20% foot, and 12% hip, and 6% calf.[3] Medial knee pain is most often caused from poor turnout technique.[10] The correct form includes knees over toes and pressure directly through the center of both knees and ankles. In the turnout position if pressure is placed on the medial aspect of the knee can lead to medial collateral ligament sprains, metatarsophalangeal joint strains and pronation of the feet.[10] Medial meniscal tears are caused by rotating the feet into farther external rotation during the descending portion of a plié to increase turnout.[10] This movement increases patellar compression and compromises knee joint stability.[13] Snapping hip syndrome is caused by movements that require turnout position; grand battement, grande plié, and développé à la seconde.[25] Snapping hip syndrome is a very common injury with 91% of dancers reporting and 58% of those causing pain.[25]

A study was performed on 204 modern and contemporary dancers, where dancers completed questionnaires to self-report injuries, which showed 90% had a history of at least one dance related injury, and 34% were currently injured.[23] Injuries were located at the lower back, knee, thigh, hip, and shoulder.[23] Out of 204 participants, 21% indicated

having pain in more than one area, even up to 6 different body parts.[23] Lee and colleagues[6] studied 56 ballet and modern dancers for an academic year. There was 125 reported injuries in one year, with the most common sites at the ankle, followed by the knee, foot, hip/thigh, and thoracic spine.[6] The total number of injuries recorded indicated 59.2% were time lost, where 86% took ≤7 days off practices and/or performances. [6] In another study of 1,236 dancers, there was a total of 2,198 injuries.[26] Research showed a vast difference between the two categories of injuries with 749(34.1%) documented as traumatic injuries and 1,449(65.9%) were overuse injuries.[26]

Contributing Factors to Injury

Training errors and biomechanical imbalances are the root of dance injuries.[8] Poor turnout technique and compensation are two of the main causes for lower extremity injury.[2,5,8] When a dancer understands the correct pattern of recruiting muscles and practicing good mechanical execution, it increases their skill and decreases the likelihood of injury.[13] This includes a dancer understanding their hypermobile physique, and the necessity for equal strength to control the movement.[27] Otherwise a wide array of stressors will occur.

There is a relationship between poor dynamic alignment when landing, and lower extremity injury risk.[24] Excessive knee valgus at the hips and knees affects the transverse and frontal plane kinematics.[24] Compensated turnout mechanisms can be seen with anterior pelvic tilt and lumbar lordosis which creates a pattern of pronated feet, hyperextended knees, and forcing the rib cage to extend forward, and is overall correlated with a high injury risk.[8,10] By externally rotating the entire lower extremity farther, the demand of the standard 180^{o} turnout can be achieved.

Proper Functional Turnout

Dancer's use "turnout" frequently as one of their five positions for ballet (see Figure 1). Turnout is defined as external rotation of the ballet dancer's legs and feet, and the feet are rotated 180° away from each other on the longitudinal axis.[8] Proper turnout requires strength, flexibility, and neural activation patterns at the hip.[10] It is a desired quality to have femoral retroversion, because it allows for even greater external rotation at the hip.[10]

Figure 1. Ballet positions 1-5. (top left: first position, top middle: second position, top right: third position, bottom left: fourth position, bottom right: fifth position)

Compensated Turnout

The majority of dancers do not have the natural 180° rotation and achieve this position through compensatory motions. Dancers typically use only 49° (36%) of bilateral hip external rotation, while non-hip contributors include; tibial torsion, knee rotation, and femoral torsion.[10,28] This creates a pattern of pronated feet, hyperextended knees, anterior pelvic tilt, and forcing the rib cage to extend forward.[10]

The average external rotation at the hips is 70° unilaterally (i.e., 140° external rotation bilaterally). To achieve 180° of hip external rotation dancers will compensate by rotating the lower extremity 20° unilaterally.[8] Each of the five positions are the beginning or ending of a movement, and have knees straight with legs externally rotated from the hips.[8]Achieving hip external rotation of 180° is not only a technical goal for all dancers,[5] but is often a requirement to be hired into a professional performing arts company.[8]

Compensated Turnout and Injury Risk

There is a significant correlation between forcing turnout and high injury rates in a variety of dance styles.[5,8,23] In 22 university level modern dancers, ages 19-23, active hip external rotation and functional turnout were measured. For each dancer, their functional turnout was considered their normal. Functional turnout and the addition of left and right active hip external rotation was calculated to determine compensated turnout. In addition to the measurements, dancers filled out questionnaires describing injuries from the past two years. Results showed all dancers had some degree of compensated turnout, ranging from 3°-72°.[5] The data showed compensated turnout was significantly related to injury rates. In addition, 80% of dancers who compensated more than 25° had more than one injury.[5]

Another study found similar results when looking at the association of compensated turnout and self-reported injury in ballet dancers. Thirty collegiate level

ballet dancers and teachers, ages 16-50, filled out a questionnaire stating all injuries. Three measurements were recorded on both legs including passive internal rotation, passive external rotation, and first position. Compensated turnout was calculated taking the functional turnout and the total degrees of passive hip external rotation. Results revealed 47% had self-reported injury, and 7 of that group had more than 1 injury. There was a significant difference between non-injury and injury groups when comparing functional turnout and compensated turnout (functional turnout; P=0.004, compensated turnout; P=0.006; $p<0.05$).[8] The injured group had an average 20.8° greater in compensated turnout.[8]

Screening Turnout as a Mechanism for Reducing Injury Prevalence

There are multiple steps to reduce injury risk, which begins with identifying dancers who have the highest risk for developing musculoskeletal dysfunction.[29] Research shows a new emphasis being placed on strength training, as well as stretching, to not only increase range of motion but decrease injury incidence.[30] Dancers need be self-aware and work towards enhancing proprioceptive and strong core stability.[29] To work on proper turnout, dancers need to "track their knees", by confirming each knee is traveling over the second toe.[28] In addition, external preventative measures include using spring, or even floors, a warmer studio, and allowing the body necessary recovery time.[29] To assist in the reduction of injuries, implementing a pre-season screening would provide data to discover current pathologies, and specifically define population characteristics.[31] Dancers have a more positive reaction when injury prevention is a main focus, and the medical support provided is beneficial and positive.[18]

There are three components to creating a comprehensive and thorough screening process which include; intrinsic risk factors, extrinsic risk tracking, and an injury

occurrence reporting system.[31] By highlighting the areas of concern, medical staff can detect injuries quicker, and better manage them.[29] This benefits both the dancer and company to minimize time lost, the psychological impact that accompanies injury, and possible setbacks in the athlete's career.[29] High schools, collegiate settings, and the professional level of all sports entail a pre-season physical before granted consent to participate, and this same concept should be applied at the collegiate level, professional companies, and private studios. Initiating on site care for all dance companies would drastically reduce the cost for companies to treat both acute and chronic injuries for both professional and pre-professional levels.

Limitations of Current Research

Ballet is the predominant style referred to the most, is heavily examined for turnout/injuries, and has the highest scientific research.[2,5] It has become increasingly popular, which has placed little focus on other dance styles. A search of several research databases returned 113 articles when using the keywords, *ballet* and *turnout*. Applying the terms *jazz* and *turnout* into the same databases returns 0 research articles.

Differences Between Jazz and Ballet

Jazz and ballet have been found to have unique qualities and physical demands of performance.[32] Although it is common practice to generalize the results from research involving ballet dancers to all dancers this practice is unsubstantiated. Differences can be seen in the muscular demands, anatomical body types, and specific choreography between the different dance styles which suggests that research on one style of dance may not necessarily apply to other dance styles.[11] Jazz dance is unique in both its presentation and character captured on stage. This is due to its intricate style of expression, which has

evolved drastically over the past century.[11] It is full of sophisticated and earthy movements combined to create an overall strong tone.[11]

In ballet you see the torso moving as one piece,[11] and is full of soft and controlled movements. Jazz dance emphasizes isolations of the ribcage and flexibility of the spine. Jazz is full of distinct movement characteristics, rhythmic patterns, and unique choreography.[11] Two specific elements jazz carries is extreme emotion and a social connection. The dancer uses his/her body to express feelings using body language. Jazz dancers have individual creativity with improvisation, vocal encouragement, and lack of separation with performer and spectator.[11]

In today's society jazz takes on a theatrical style seen on Broadway productions, with high energy and quick paced movements.[11] Jazz is broken down into classical, commercial, concert, contemporary, and pop jazz, which is performed at competitions, conventions, and private dance studios. Jazz dance has become one of the most central styles due to its wide-reaching influence worldwide.[11]

Significance of Jazz Turnout

The overall kinetic elements jazz transmits includes; flat feet, bent hip, knee, and ankle joints, inclined torso, isolations, asymmetry, and groundedness.[11] The knees are primarily bent, which allows a more natural movement with the lower extremity in a parallel position.[11] The original movement begins in the hips, with a sharp impulse, and releases into the legs and arms with a fading flow of energy.[11]

In ballet turnout and the extreme 180^{o} is critical, however other styles, like jazz, require transition between parallel and turnout position.[5] No other sport requires the maximum external rotation like dance does, it is a unique requirement but one of the most important.[10] This proves dancers with different styles may not have the same turnout

function and lower tolerance for hip external rotation.[5] Even with the little data provided on jazz dancers, one study demonstrated a case for necessary medical research. In 46 jazz dancers there were 57 injuries, which accounted for 28% of the dancer population used for the study.[7]

Statement of Problem

Dancers are unique athletes with a different structural build and a high volume of injuries which stem from repetitive movements, intense competition, and drive for perfection. The reduction of dance injuries is the end goal, but getting a better understanding of how and why these injuries occur is the initial vital piece. As clinicians in the performing arts setting, being cautious when forcing a dancer to externally rotate, showing them proper technique, and educating them is key to ensure the athlete lives out their full dance career.

Jazz dancers carry their own distinctive characteristics which can be seen performed across the globe. They are lacking in literature that can be applied to their training and specific movement. There are currently no published studies that directly compare the differences in turnout between ballet and jazz dancers.

Specific Aims

[1] To determine if there are differences in external hip rotation during functional and compensated turnout between ballet, jazz, and non-dancers.

[2] To examine the relationship between compensated turnout and injury history in ballet and jazz dancers.

[3] To determine the compensatory motions most frequently used during compensated turnout.

III. METHODS

This study examines the rate of turnout in three different populations; jazz, ballet, and non-dancers. This chapter will describe the design of the study, participants involved, instrumentation, procedures, and data analyses.

Participants

Female ballet, jazz, and non-dancers were recruited for this study using convenience sampling techniques. A power analysis was conducted for this study (group size = 3, power = .8, alpha=.05, effect size=0.4) which suggested a minimum sample size of 66 participants was required (22 ballet, 22 jazz, and 22 non-dancers [control group]). Jazz dancers were recruited from the universities dance program and locally owned dance studios. Ballet dancers were recruited from locally owned dance studios and semi-professional companies. Non-dancers were recruited from undergraduate courses at Texas State University. To account for potential participant dropout and noncompliance, oversampling techniques were used resulting in a final sample size of 75 participants (25 ballet, 25 jazz, and 25 non-dancers). Dancers were eligible for inclusion if they self-identified as a ballet or jazz dancer. Dancers were recruited from a range of skill levels including amateur, collegiate, and semi-professional. Non-dancers were included to serve as a control group. All participants were over the age of 18 at time of recruitment and female. Participants with any surgeries or major lower extremity injuries within the past 12 months were excluded.

Procedures

The procedures for this study were approved by the Texas State Universities Institutional Research Board prior to the start of data collection. Dancers were recruited through email and word of mouth. Participants met with the principal investigator in a

dance studio or athletic training room to explain the study, obtain informed consent, and complete a brief demographic questionnaire. The questionnaire (see Appendix D) collected information related to the participants age, height, weight, dance experience, preferred dance style, and self-reported injury history in the last 5 years (both diagnosed and undiagnosed).

To accurately assess functional turnout the Functional Footprints (Balanced Body, Sacramento, CA) measurement tool (see Figure 2) was used. The Functional Footprints is a lightweight tool designed to train dancers to perform turnout properly, without compensation, to prevent injury. Functional Footprints have been used to examine the relationship between standing active turnout and femoral bony morphology.[30] The device demonstrates good intrarater (ICC = .85-.88) and interrater reliability (ICC = .82-.88) for

Figure 2: Functional Footprints

assessment of external hip rotation.[33] A 23” x 35” standard whiteboard (see Figure 3a) was used to measure compensated and functional turnout with an extendable goniometer (see Figure 3b). A Canon Powershot G11 10-megapixel digital camera (see Figure 4) was used to photograph the lower extremity of all participants when performing turnout. No faces were included in the photographs to maintain participant confidentiality. Photographs were taken of each participant from the anterior and lateral views following each measurement by the principal investigator who stood an average of 5 feet away each direction.

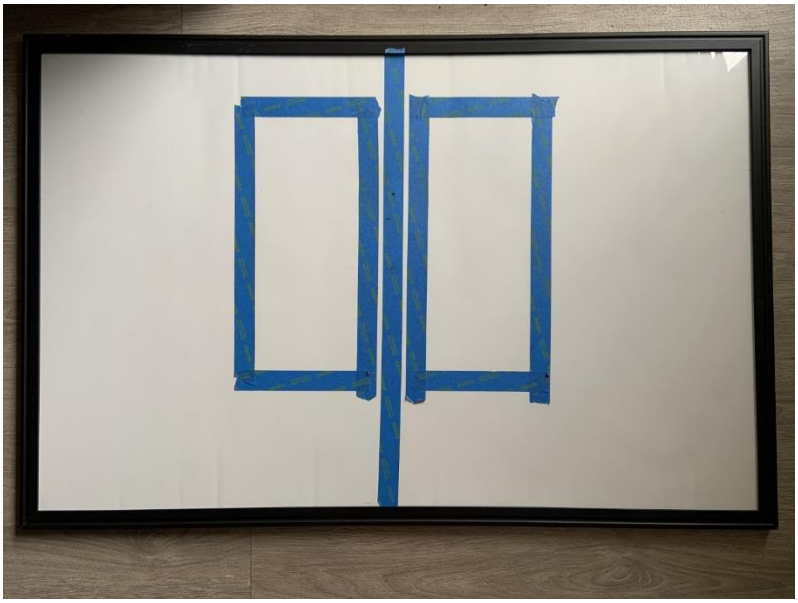

Figure 3a. 23” x 35” whiteboard pre-marked out with tape.

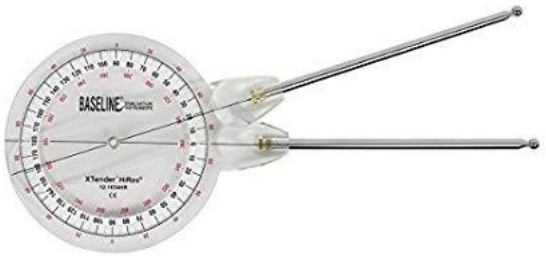

Figure 3b. Extendable goniometer

Figure 4. Canon Powershot G11 10-megapixel digital camera.

Measurement Protocol

The technique used to collect data for this study was adapted from Greene et al.[33] All functional and compensated measurements were collected by the principal investigator to ensure consistent results. Prior to measurement all participants completed

a general warm-up consisting of ten grand plies. Non-dancers were given a demonstration by the principal investigator to demonstrate proper technique for a plie. All participants were tested bare foot and instructed to give the same level of effort for all trials performed. Three trials were performed for both functional and compensated turnout (six total trials). The order for performing functional and compensated turnout was randomized for each participant. Half of the participants completed functional turnout first, while the second half of participants completed compensated turnout first.

Compensated turnout was measured using a whiteboard with a line bisecting the board and extendable goniometer. Dancers were asked to stand in first position with their arms in second position. Non-dancers were provided a demonstration by the principal investigator of proper technique to stand on the device, as well as arm placement. They were instructed to stand with their heels centered over the line (see Figure 5). No additional cues were stated by the principal investigator to ensure a true measurement of compensated turnout. The principal investigator palpated the second metatarsal and used a ruler as a straightedge to draw a line extending from the second metatarsal. Once the participant stepped off the whiteboard the principal investigator used an extendable goniometer to measure the angle by placing the axis at the bisection of the fixed centerline, and the arms of the goniometer on the second metatarsal line. There was approximately 30-45 seconds between each trial.

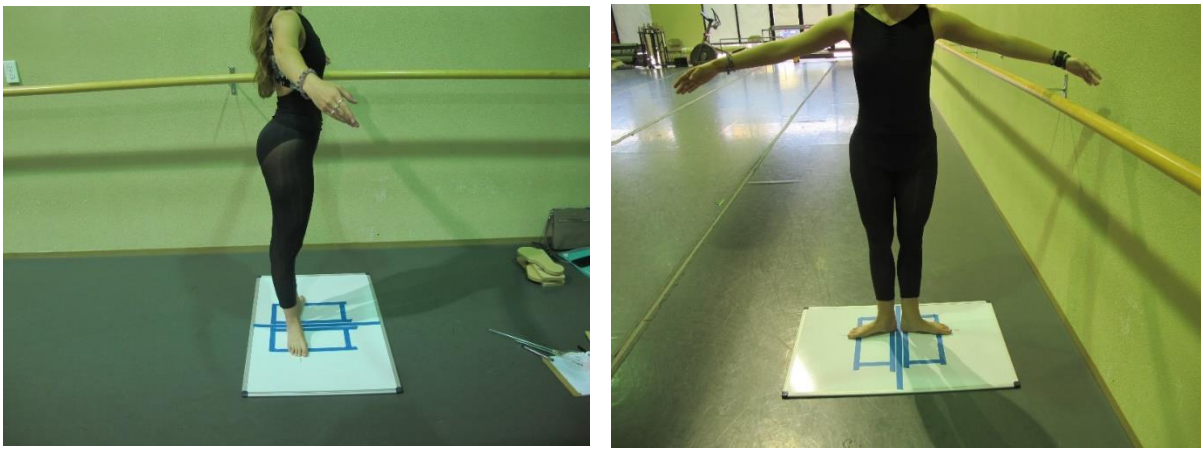

Figure 5. Ballet dancer demonstrating first position with arms in second.

To measure functional turnout, an extendable goniometer was used while the participant stood on the Functional Footprints, on a pre-marked area of the whiteboard. The Functional Footprints entail a resistance-free swivel that prevents a participant from using any compensation techniques to increase turnout. The board is unstable in the sagittal plane, which makes it difficult for participants to rely on lumbopelvic motion and will automatically tip forward if anterior tilt is performed to increase turnout.

Participants used a barre or wall for balance while stepping on the Functional Footprints. The medial malleolus aligned with the horizontal axis line, the bisection of the calcaneus aligned with the vertical line at the back of the device, and the second toe was placed to align with the marking at the front of the board. Dancers began in parallel position when stepping on the Functional Footprints and opened into first position, without tipping it forward, and their arms placed in second position. The clinician palpated the second metatarsal and used a ruler as a straightedge to draw a line extending straight out. When the dancer steps off, the extendable goniometer measured the angle by

placing the axis at the bisection of the fixed centerline, and the arms of the goniometer on the second metatarsal line. There was approximately 30-45 seconds between each trial for a total of 3 measurements.

To identify the compensatory motions most frequently used during compensated turnout the principal investigator examined the photographs from each trial. Each compensatory motion was identified. Frequencies for each type of compensatory motion were tallied. The principal investigator evaluated the photos by beginning from the head and working down to chest/shoulders, back, hips, knees, and feet. Compensatory mechanisms such as forward head, open chest, anterior pelvic tilt, genu recurvatum, pronated feet and more would receive one tally per compensation if observed.

Statistical Analysis

All analyses for this study were conducted using SPSS v.25 (SPSS Inc. International Business Machines Corporation, Armonk, New York). To evaluate differences hip external rotation in functional and compensated turnout between ballet, jazz, and non-dancers a 3 x 2 repeated measures ANOVA's were used for left and right hips respectively. The between-subjects factor was group (ballet, jazz, or non-dancer) and the within-subjects factor was average external hip rotation (functional turnout or compensated turnout). Follow-up analyses using dependent t-test were used to evaluate group differences in external hip rotation following functional or compensated turnout within each group. To determine if there was a significant relationship between self-reported injury history and the amount of compensation used among dancers a correlation analysis was used. Degree of compensation was determined as the difference between external hip rotation for functional and compensated turnout (compensation=compensated turnout-functional turnout). No injury data were collected

for non-dancers therefore they were excluded from this analysis. Alpha level was set at .05 for all analyses. The frequency and type of compensatory motions used were identified and tallied from the lower extremity photographs by the principal investigator during each trial.

IV. MANUSCRIPT

Dancers use turnout frequently when moving through the five basic ballet positions for the feet,[8] and is a key element during many technical movements. There are high injury rates among elite adolescent and professional dancers.[24] Injury prevalence in dancers ranges from 42-95%, across multiple genres and levels, including pre-professional and professional.[2] At the New York City Ballet, 17% of dancers are not practicing or performing due to injury.[8] Due to the repetitive movements required during ballet and jazz performances, overuse injuries make up the majority of dance-related injuries, with most occurring at the foot and ankle.[3-7]

Poor turnout technique and compensation are two of the main causes for lower extremity injury in dancers.[2,5] Proper functional turnout requires strength, flexibility, and neural activation patterns at the hip.[10] The majority of dancers do not have the natural 180^{o} external hip rotation and achieve this position through compensatory motions. Compensated turnout mechanisms can be seen with anterior pelvic tilt and lumbar lordosis.[10,11] These compensatory motions create a pattern of pronated feet, hyperextended knees, and forces the rib cage to extend forward, which is overall correlated with a high injury risk.[8,10] These compensations can strain certain areas of musculature from overuse and/or create a pattern of weakness which can have a large effect on the aesthetics of the dancer.

Dancers from different styles of training may have differences in turnout function and tolerance for external hip rotation.[5] The majority of research investigating effects of compensation on injury risk is limited to ballet dancers. A search of several research databases returned 113 articles when using the keywords, *ballet* and *turnout*. Applying the terms *jazz* and *turnout* into the same databases returns 0 research articles. This is

problematic because of the differences in the muscular demands, body morphology, and specific choreography between ballet dancers and dancers from other dance styles such as jazz dance.[11] In ballet the extreme 180° of turnout is critical for standards in this dance discipline, however, jazz requires transitions between parallel and turnout foot positions.[5] Improved understanding of the differences in turnout ability between ballet and jazz dancers is important because the injury prevention programs, as well as training and rehabilitation techniques, that are developed for ballet dancers may not be appropriate for jazz dancers. Therefore, the purposes of this study were to [1] compare external hip rotation during functional and compensated turnout in ballet and jazz dancers; [2] examine the relationship between the degree of compensation and injury history; and [3] identify the compensatory motions most frequently used during compensated turnout.

Methods

Female ballet, jazz, and non-dancers were recruited for this study using convenience sampling techniques. A power analysis was conducted for this study (group size = 3, power = .8, alpha=.05, effect size=0.4) which suggested a minimum sample size of 66 participants was required (22 ballet, 22 jazz, and 22 non-dancers [control group]). Jazz dancers were recruited from the universities dance program and locally owned dance studios. Ballet dancers were recruited from locally owned dance studios and semi-professional companies. Non-dancers were recruited from undergraduate courses at Texas State University. To account for potential participant dropout and noncompliance, oversampling techniques were used resulting in a final sample size of 75 participants (25 ballet, 25 jazz, and 25 non-dancers). Dancers were eligible for inclusion if they self-identified as a ballet or jazz dancer. Dancers were recruited from a range of skill levels including amateur, collegiate, and semi-professional. Non-dancers were included to serve

as a control group. All participants were over the age of 18 at time of recruitment and female. Participants with any surgeries or major lower extremity injuries within the past 12 months were excluded.

Procedures

The procedures for this study were approved by the Texas State Universities Institutional Research Board prior to the start of data collection. Dancers were recruited through email and word of mouth. Participants met with the principal investigator in a dance studio or athletic training room to explain the study, obtain informed consent, and complete a brief demographic questionnaire. The questionnaire (see Appendix D) collected information related to the participants age, height, weight, dance experience, preferred dance style, and self-reported injury history in the last 5 years (both diagnosed and undiagnosed).

To accurately assess functional turnout the Functional Footprints (Balanced Body, Sacramento, CA) measurement tool (see Figure 2) was used.

Figure 2: Functional Footprints

The Functional Footprints is a lightweight tool designed to train dancers to perform turnout properly, without compensation, to prevent injury. Functional Footprints have been used to examine the relationship between standing active turnout and femoral bony morphology.[30] The device demonstrates good intrarater (ICC = .85-.88) and interrater reliability (ICC = .82-.88) for assessment of external hip rotation.[33] A 23" x 35" standard whiteboard (see Figure 3a) was used to measure compensated and functional turnout with an extendable goniometer (see Figure 3b). A Canon Powershot G11 10-megapixel digital camera (see Figure 4) was used to photograph the lower extremity of all participants when performing turnout. No faces were included in the photographs to maintain participant confidentiality. Photographs were taken of each participant from the anterior and lateral views following each measurement by the principal investigator who stood an average of 5 feet away each direction.

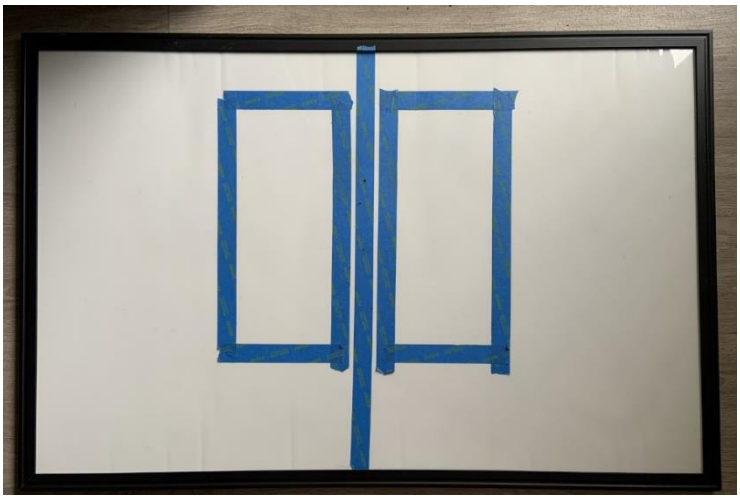

Figure 3a. 23” x 35” whiteboard pre-marked out with tape.

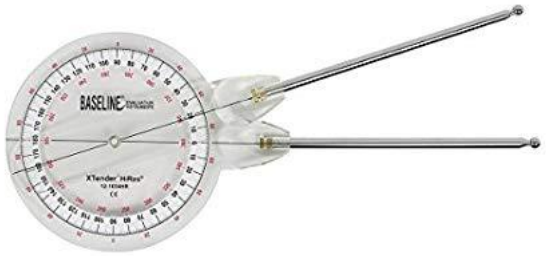

Figure 3b. Extendable goniometer

Figure 4. Canon Powershot G11 10-megapixel digital camera.

Measurement Protocol

The technique used to collect data for this study was adapted from Greene et al.[33] All functional and compensated measurements were collected by the principal investigator to ensure consistent results. Prior to measurement all participants completed a general warm-up consisting of ten grand plies. Non-dancers were given a demonstration by the principal investigator to demonstrate proper technique for a plie. All participants

were tested bare foot and instructed to give the same level of effort for all trials performed. Three trials were performed for both functional and compensated turnout (six total trials). The order for performing functional and compensated turnout was randomized for each participant. Half of the participants completed functional turnout first, while the second half of participants completed compensated turnout first.

Compensated turnout was measured using a whiteboard with a line bisecting the board and extendable goniometer. Dancers were asked to stand in first position with their arms in second position. Non-dancers were provided a demonstration by the principal investigator of proper technique to stand on the device, as well as arm placement. They were instructed to stand with their heels centered over the line (see Figure 5).

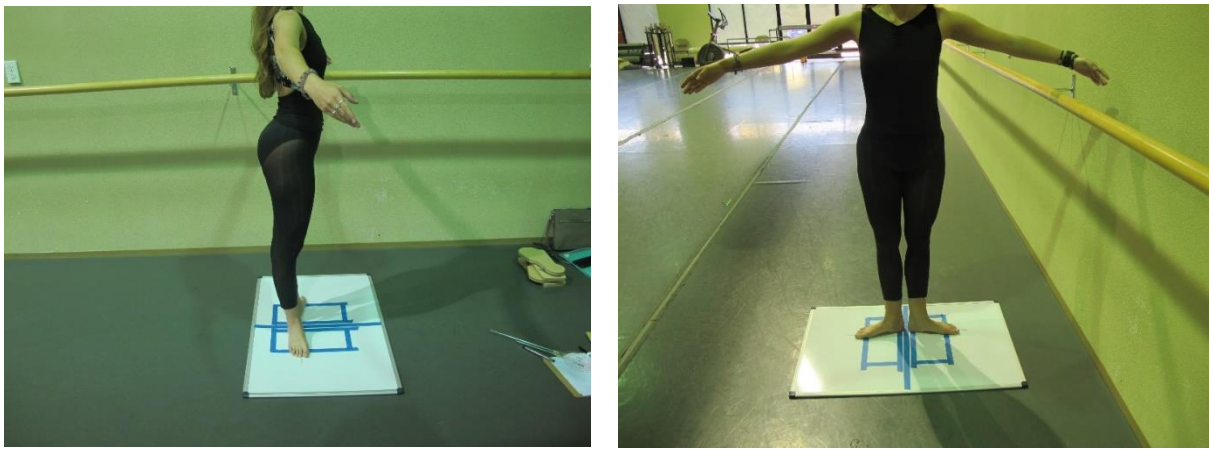

Figure 5. Ballet dancer demonstrating first position with arms in second.

No additional cues were stated by the principal investigator to ensure a true measurement of compensated turnout. The principal investigator palpated the second metatarsal and used a ruler as a straightedge to draw a line extending from the second metatarsal. Once the participant stepped off the whiteboard the principal investigator used an extendable goniometer to measure the angle by placing the axis at the bisection of the fixed centerline, and the arms of the goniometer on the second metatarsal line. There was approximately 30-45 seconds between each trial.

To measure functional turnout, an extendable goniometer was used while the participant stood on the Functional Footprints, on a pre-marked area of the whiteboard. The Functional Footprints entail a resistance-free swivel that prevents a participant from using any compensation techniques to increase turnout. The board is unstable in the sagittal plane, which makes it difficult for participants to rely on lumbopelvic motion and will automatically tip forward if anterior tilt is performed to increase turnout.

Participants used a barre or wall for balance while stepping on the Functional Footprints. The medial malleolus aligned with the horizontal axis line, the bisection of the calcaneus aligned with the vertical line at the back of the device, and the second toe was placed to align with the marking at the front of the board. Dancers began in parallel position when stepping on the Functional Footprints and opened into first position, without tipping it forward, and their arms placed in second position. The clinician palpated the second metatarsal and used a ruler as a straightedge to draw a line extending straight out. When the dancer steps off, the extendable goniometer measured the angle by placing the axis at the bisection of the fixed centerline, and the arms of the goniometer on the second metatarsal line. There was approximately 30-45 seconds between each trial for a total of 3 measurements.

To identify the compensatory motions most frequently used during compensated turnout the principal investigator examined the photographs from each trial. Each compensatory motion was identified. Frequencies for each type of compensatory motion were tallied. The principal investigator evaluated the photos by beginning from the head and working down to chest/shoulders, back, hips, knees, and feet. Compensatory mechanisms such as forward head, open chest, anterior pelvic tilt, genu recurvatum, pronated feet and more would receive one tally per compensation if observed.

Statistical Analysis

All analyses for this study were conducted using SPSS v.25 (SPSS Inc. International Business Machines Corporation, Armonk, New York). To evaluate differences hip external rotation in functional and compensated turnout between ballet, jazz, and non-dancers a 3 x 2 repeated measures ANOVA's were used for left and right hips respectively. The between-subjects factor was group (ballet, jazz, or non-dancer) and the within-subjects factor was average external hip rotation (functional turnout or compensated turnout). Follow-up analyses using dependent t-test were used to evaluate group differences in external hip rotation following functional or compensated turnout within each group. To determine if there was a significant relationship between self-reported injury history and the amount of compensation used among dancers a correlation analysis was used. Degree of compensation was determined as the difference between external hip rotation for functional and compensated turnout (compensation=compensated turnout-functional turnout). No injury data were collected for non-dancers therefore they were excluded from this analysis. Alpha level was set at .05 for all analyses. The frequency and type of compensatory motions used were

identified and tallied from the lower extremity photographs by the principal investigator during each trial.

Results

All 75 participants completed all measurement procedures. None of the participants dropped out or were excluded for non-compliance. Participant demographics are reported in Table 1 for all three groups.

Table 1. Participant Demographics

	Ballet	Jazz	Non-Dancer
Age (y)	25.36±5.52	19.96±1.88	20.48±1.44
Height (cm)	163.49±6.35	165.63±8.23	165.21±7.21
Weight (kg)	54.63±7.15	64.8±9.9	66.54±15.8
Dance Experience (Yrs)	19.60±5.66	13.64±5.13	N/A
Number of Injuries per Dancer	2.40±1.44	1.73±1.60	N/A

The average functional and compensated turnout across trials for each leg are reported in Table 2. Results from the 3 x 2 repeated measures ANOVA indicated a significant interaction effect between group and average external hip rotation for the right ($F_{2,72}$=12.01; p<.01) and left leg ($F_{2,72}$=11.24; p<.01), respectively.

Table 2. Functional and Compensated Average Turnout Measurements

	Left			Right		
	Functional	Compensated	p	Functional	Compensated	p
Ballet	66.55±7.31	72.30±9.88	<.001	65.94±7.67	72.16±10.15	<.001
Jazz	57.43±5.32	60.44±8.13	.003	57.35±4.97	59.55±7.77	.030
Non-dancer	54.06±6.42	53.49±7.30	.564	53.58±8.20	53.08±7.36	.599

Note. This table displays the average external hip rotation following functional and compensated turnout for each group. Each turnout procedure was conducted three times each. Significance was determined using three dependent t-test. Alpha level was set at .05.

Follow-up analyses using dependent t-tests indicated significant mean differences in external hip rotation between functional and compensated turnout for ballet dancers (R: $t_{24} = -6.06$; $p<.01$ | L: $t_{24} = -6.13$; $p<.01$) and jazz dancers (R: $t_{24} = -2.31$; $p = .03$ | L: $t_{24} = -3.29$; $p = .003$) but not for non-dancers (R: $t_{24} = 0.53$; $p = .60$ | L: $t_{24} = 0.58$; $p = .56$) for both the right and left legs, respectively. This suggests that both ballet and jazz dancers used compensatory movements to increase their external hip rotation during turnout. Pairwise comparisons of functional and compensated turnout across groups indicated that external hip rotation in ballet dancers was significantly greater than jazz dancers and non-dancers for both functional turnout (R: $p<.01$ | L: $p<.01$) and compensated turnout (R: $p<.01$ | L: $p<.01$). Significant differences in external hip rotation were also found between jazz dancers and non-dancers during compensated turnout (R: $p<.01$ | L: $p<.01$); but not

during functional turnout (R: p = .13 | L: p = .20). No relationship was identified between the number of self-reported injuries and the degree of compensation in dancers (R: *r* = .09; p = .56 | L: *r* = .02; p = .90). A total of 300 photographs were taken and reviewed by the principal investigator (50 participants x 3 trials for lateral and anterior views). Across all photographs there was 84 total compensations during compensated turnout. A detailed breakdown listing the frequency and type of compensations from each view are listed in Table 3.

Table 3. Snapshot Photos

		Genu Recurvatum	Foot Pronation
Anterior view	Ballet	9	6
	Jazz	18	0
		Flat Back Posture	Anterior Pelvic Tilt
Lateral view	Ballet	12	12
	Jazz	6	21

Note. The following table represents the number of compensations identified from lower extremity photos. For both the anterior and lateral views a total of 84 compensations were identified from 300 photographs of the lower extremity during compensated turnout (2 views x 50 participants x 3 trials). Multiple compensations were observed in each photograph.

An example illustrating the difference between a dancer with no compensations, (Figure 6a) to a dancer with pronated feet and anterior pelvic tilt in Figure 6b.


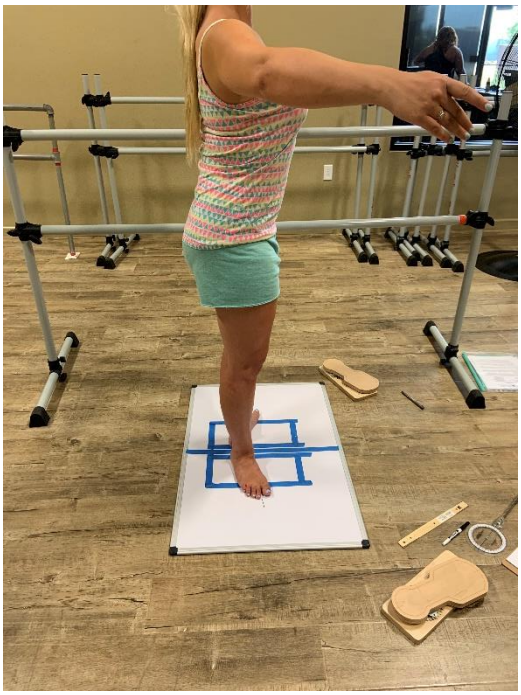

Figure 6a. Jazz dancer with no compensations during compensated turnout.

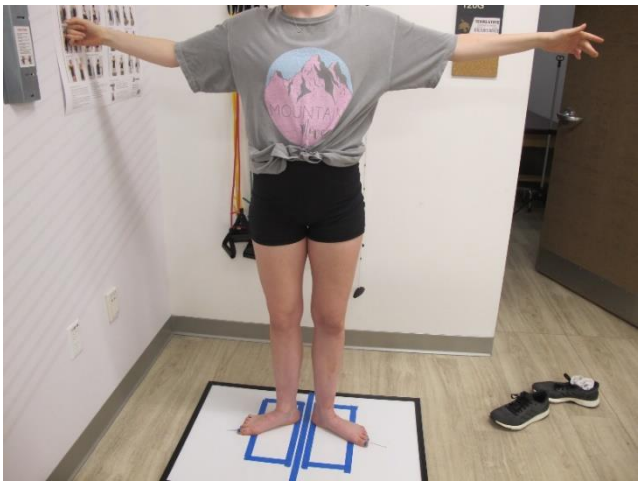


Figure 6b. Jazz dancer with pronated feet and anterior pelvic tilt during compensated turnout.

Discussion

To our knowledge this is the first study evaluating turnout in both ballet and jazz dancers. Ballet dancers had greater turnout which can be attributed to multiple factors. The ballet group has more years of experience, 19.6±5.6, compared to the jazz group, 13.6±5.1. In addition, the athletic level (i.e., semi-professional vs. collegiate) may be a strong possibility for such a vast difference. Harmon-Matthews and colleagues evaluated turnout using a floor protractor for compensated turnout and Functional Footprints for functional turnout, in 3 different ballet populations: professional, collegiate, and academy.[34] Results showed collegiate dancers had average functional turnout of 105.4°±16.5°, which was significantly smaller than both professionals, 127.6°±14.4°, and academy students, 123.9°±17.6°.[34]

The external hip rotation observed during functional and compensated turnout during this study were similar to those observed in previous research using rotational discs. Harmon-Matthews et al. demonstrated increased external hip rotation when comparing functional to compensated turnout. All three groups observed (e.g., professional, collegiate, and academy) had an average of 10° greater external hip rotation during compensated turnout compared to their external hip rotation during functional turnout. The average degree of compensation for the right hip was 6.22±5.13, 2.20±4.75, and -0.51±4.76 for ballet, jazz, and non-dancers, respectively. The average degree of compensation for the left hip was 5.75±4.69, 3.01±4.57, and -0.57±4.92 for ballet, jazz, and non-dancers, respectively. This demonstrates dancers of all levels compensate to achieve the desired 180° turnout. A study by Tachibana and colleagues demonstrated increases in external hip rotation during turnout between class (compensated), active

external rotation of the lower extremity, and a newly designed rotational goniometer (RGM), a device of friction-free-surface, similar to Functional Footprints.[35] Twenty female Japanese dancers with greater than 10 years of ballet experience had an average 103.89°±15.2° functional turnout on RGM device and 128.7°±15.1° compensated turnout.[35]

Jazz dancers had greater compensation during compensated turnout in their left hip compared with their right hip. A large fraction, 80%, of the general population is right footed[36] and dancers tend to have an asymmetrical body structure in addition to preference for learning and performing skills.[36] Harmon-Matthews and colleagues found similar results to this study with their professional dancers having an average 4° more turnout on the left leg.[34] It is assumed dancers will follow the general population and have lateral biases for performing dance skills.[36] The difference between non-dominant and dominant legs is dependent upon the complexity of the task and relationship between the stabilizing and moving leg. To perform bilateral tasks an individual will use their dominant leg to perform the more difficult action while the non-dominant becomes the support.[36] Additionally range of motion overrides balance, which means that dancers may switch to the left leg more often because the body has to maintain balance, strength, and flexibility while simultaneously accounting for body structure, past training, and injury history.[36]

The lack of relationship found between degree of compensation and injury history in this study contradicts findings from previous research. Van Merkensteijn et al.[5] measured active hip external rotation and functional turnout, where compensated was calculated using the difference of the two. Results indicated that the degree of compensation was significantly associated with injury rates. Van Merkenstejn and

colleagues had a smaller sample size of 22 dancers and used a different measurement protocol by having the participant lay prone to get active hip external rotation. Coplan et al.[8] also found similar results while using the same prone measuring technique on 30 collegiate-level ballet dancers and teachers. Measurements included passive hip internal and external rotation as well as basic first position. The use of a prone rather than standing technique may partially explain the differences in results.

The snapshot photos showed that 52% of ballet dancers had a visible compensatory mechanism, while jazz dancers had 56%. Ballet dancers statistically had the largest compensation which aligns with the type of compensatory mechanisms that were visible. The majority of jazz dancers had genu recurvatum, which can allow for greater turnout, but is not technically a mechanism that can be strived for, but something an individual is born with and exacerbated with consistent day to day training. This aligns with Solomon et al. research which discussed the average dancer uses 49^{o} of bilateral external rotation of each hip. The rest of turnout comes from compensatory mechanisms such as pronated feet, hyperextended knees, anterior pelvic tilt, and forcing the rib cage to extend forward, which are common alignment issues in dance and with careful continuous work can be eliminated.[10]

This study was not without limitations. Firstly, all ballet dancers were pre-professional, while the jazz population were amateur/collegiate level, which could have been a large factor for increased turnout. Dancers were excluded if they had any surgeries or major lower extremity injuries within the last year, which may have been a primary reason no significance was found between turnout and injury rate. These dancers were omitted for safety concerns of placing the athlete with a current lower extremity injury on an unstable surface. There were variations in dance training among the jazz and ballet

dancers, with jazz dancers averaging 13.6 years of training, while ballet had an average 19.6. A large limitation was the retrospective nature of this study, which required participants to recall from their memory, dates and information on their injuries both within the last year as well as 5 years. There was no reliability testing calculated for reviewing and determining compensatory motions for the Snapshot photos. Future research should focus on collecting data on dancers from the same company and/or level of competition. As well as using a prospective model to collect injury information or use a team physician with the dancers documented background to confirm injuries.

Between both ballet and jazz dance groups, 82% had at least one injury and the highest number being 7 injuries over the last 5 years. Although no significance was found between the degree of compensation and injury rate in ballet and jazz dancers, this is still an extremely high percentage. This evidence strongly suggests the need to create a screening process for all dancers performing in companies, studios, etc. All sports at a highly competitive level have some sort of physical completed pre-competition, and dance is no different. By identifying early on the compensatory mechanisms, clinicians can assist dancers in preventing injury and altering their lower extremity biomechanics. In the long run this will increase the dancer's career and could possibly reduce time lost due to injury.

The evidence from ballet research is demonstrated not to be applicable to jazz dancers. Jazz dancers have varying body types and overall a lower degree of external hip rotation during turnout but are held to the same high standard of performance at the professional level. Both dance styles train at a rigorous level, however jazz differs in the overall movement patterns, which can be seen from the evidence in this study with the overall external hip rotation during functional turnout being lower. Jazz dancers had the

same external hip rotation as the non-dancers; however, in order to achieve 180º of external hip rotation demonstrated a significant number of compensatory motions; which could lead to increased risk of injury.

Conclusion

The results of this study demonstrate the differences between external hip rotation during functional and compensated turnout between 3 groups: ballet, jazz, and non-dancers. Dancers use a variety of compensatory mechanisms to increase their external hip rotation during turnout, which can be detrimental to their bodies. In addition, the research performed on ballet dancers may not generalize to jazz dancers. Ballet dancers have a higher functional turnout due to differences in anatomical structure and training demands. Overall, more research is needed to better understand the biomechanical differences between dance styles.

APPENDIX SECTION

APPENDIX A-IRB Approval Letter

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

In future correspondence please refer to 6547

May 22, 2019

James Farnsworth, Ph.D.
Texas State University
601 University Dr.
San Marcos, TX 78666

Dear Dr. Farnsworth:

Your application titled, "Comparison of functional and compensated turnout between ballet and jazz dancers." was reviewed by the Texas State University IRB and approved. It was determined there are: (1) research procedures consistent with a sound research design and they did not expose the subjects to unnecessary risk. (2) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (3) selection of subjects are equitable; and (4) the purposes of the research and the research setting are amenable to subjects' welfare and produced desired outcomes; indications of coercion or prejudice are absent, and participation is clearly voluntary.

1. In addition, the IRB found you will orient participants as follows: (1) informed consent is required; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safeguards are included to protect the rights and welfare of the subjects. (4) Compensation will not be provided for participation.

This project was approved at the Expedited Review Level until April 30, 2020

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments, please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Research Integrity and Compliance.

Report any changes to this approved protocol to this office. Notify the IRB of any unanticipated events, serious adverse events, and breach of confidentiality within 3 days.

Sincerely,

Monica Gonzales

Monica Gonzales
IRB Regulatory Manager
Office of Research Integrity and Compliance
Texas State University

CC: Courtney Steele
Dr. Duane Knudson
Dr. Natalie Myers

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
601 University Drive | JCK #489 | San Marcos, Texas 78666-4616
Phone: 512.245.2314 | *fax:* 512.245.3847 | www.TXSTATE.EDU

APPENDIX B-Consent Form

Study Title: Comparison of Functional and Compensated Turnout in Ballet and Jazz Dancers

Principal Investigator: Courtney Steele	**Email: crs296@txstate.edu** **Phone: 209-281-7543**
Co-Investigator/Faculty Adviser: Dr. James Farnsworth	**Email: farnsworth@txstate.edu** **Phone: 512-245-2939**
Co-Investigator: Dr. Natalie Myers	**Email: nlm73@txstate.edu** **Phone: 512-245-2958**
Co-Investigator: Dr. Duane Knudson	**Email: dk19@txstate.edu** **Phone: 512-245-5589**

This consent form will give you the information you will need to understand why this research study is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

PURPOSE AND BACKGROUND

You are invited to participate in a research study to learn more about turnout and the relationship to dance-related injury. The information gathered will be used for a thesis project. You are being asked to participate because you are a female adult dancer (jazz or ballet) or non-dancer who is at least 18 years of age with no major lower extremity injuries or lower extremity surgeries within the past year.

PROCEDURES

Data collection for this study will occur in one of two locations. Data collection location will be determined based upon whether you are a dancer (jazz or ballet) or a non-dancer. For ballet dancers data collection will occur in a private dance studio at the Central West Ballet Company. For jazz dancers and non-dancers data collection will occur in the Strutters dance studio.

If you agree to be in this study, you will participate in the following:

- Complete a brief survey (approximately 5-10 minutes) which will ask you basic questions about your age, height, weight, dance history, dance style, and previous history of dance-related injuries.
- Complete 10 grand pliés (a standard dance-related warm-up procedure)
- Complete the turnout technique six times.
    - Turnout is a dance-related movement that requires an individual to externally rotate both legs at the hips while in a standing position which causes the feet and knees to turn outward, away from the

front of the body.
    - All turnouts will be performed barefoot while standing on a whiteboard or the Functional footprints device (three on the Functional footprints; three on the whiteboard).
    - The Functional footprints device is a commonly used dance training tool used to teach leg alignment without placing stress on the ankle or knees. The footprints are slightly unstable on a rotating swivel.
    - The order for each set of three measurements will be randomly selected for each participant.

- At the completion of each turnout movement you will be asked to briefly maintain that position while the principal investigator draws a line on the whiteboard indicating your position and takes a photograph of your lower extremity from the neck down. Your head and face will NOT be included in the photograph.
- After the photograph has been taken you will be asked to step off the whiteboard (or Functional Footprint device) while the principal investigator measures your hip motion using the lines drawn on the whiteboard.
- The process will then repeat until all six measurements have been completed.

RISKS/DISCOMFORTS

The survey included in this study will ask you questions about your age, height, weight, sex, and injury history. To help ensure all participants confidentiality all survey responses, your photograph, and data will remain anonymous and use unique research IDs.

Also, as a part of this study you are being as to perform the turnout maneuver while standing on the ground and on the Functional footprints. The Functional footprints device is unstable which could result in you losing your balance. The principal investigator will provide support for you while getting on and off the device to help reduce your risk of falling. In addition, while the risk is extremely minimal, with any type of physical activity or movement there is minor risk of muscular strains or sprains. To reduce this risk, you will be asked to complete a brief warm-up activity of 10 grand pliés before conducting any activities. The warm-up activity will be demonstrated to you by the principal investigator. Grand pliés are a full knee bend (like a squat for dancers).

If some of the survey questions or activities make you uncomfortable or upset, you are always free to decline to answer or to stop your participation at any time. Should you feel discomfort after participating and you are a Texas State University student, you may contact the University Health Services for counseling services at 512-245-2161. They are located 298 Student Center Dr, San Marcos, TX 78666

BENEFITS/ALTERNATIVES

There will be no direct benefit to you from participating in this study. However, the information that you provide will assist in the first step to implementing injury prevention programs by identifying the differences in turnout and the relationship to injury history.

EXTENT OF CONFIDENTIALITY

Reasonable efforts will be made to keep the personal information in your research record private and confidential. All of your survey responses, photographs, and research data will be stored on the faculty adviser's computer, which is password protected. Your name will not be listed on any datasheets or data forms with the exclusion of the consent form. Hard copies of consent forms and survey responses will be stored in a lockable file cabinet with the faculty adviser's office located in the Jower's Center at Texas State University (Room 127a). Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

PAYMENT/COMPENSATION

You will not be paid for your participation in this study.

PARTICIPATION IS VOLUNTARY

You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. In the unlikely event of an injury a certified athletic trainer will be available to evaluate your injury; however, you will be responsible for any medical treatment costs.

QUESTIONS

If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Courtney Steele: 209-281-7543 or crs296@txstate.edu or the faculty adviser for this project, Dr. James Farnsworth: 512-245-2939 or farnsworth@txstate.edu.

This project was approved by the Texas State IRB on May 22nd 2019. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Denise Gobert 512-716-2652 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-

245-2334 - (meg201@txstate.edu).

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time.

Printed Name of Study Participant	Signature of Study Participant

Signature of Person Obtaining Consent	Date

APPENDIX C- Recruitment Script Email

Recruitment Email Message Template

To: crs296@txstate.edu
From: Courtney Steele

BCC: [potential participants email]

Subject: Research Participation Invitation: Dance Turnout and Injury Risk

This email message is an approved request for participation in research that has been approved by the Texas State Institutional Review Board (IRB).

Dear potential research participant,

Members from Texas State's Department of Health and Human Performance are recruiting participants to be a part of a research project investigating turnout in ballet, jazz, and non-dancers. The research team will be measuring turnout, or hip external rotation. The study will involve you attending one testing session lasting approximately one hour. During the testing session you will complete one short survey to collect background information and six measurements of the lower extremity.

In order to participate in this study, you must be a biological female at least 18 years of age or older. Participants who have suffered a major lower extremity injury or had surgery on their lower extremity within the last year will be excluded from participation. We are seeking to recruit both non-dancers and dancers whose primary dance styles involve either jazz or ballet.

To participate in this research or ask questions about this research please contact me at Courtney Steele 209-281-7543 – (crs296@txstate.edu).

This project IRB #6547 was approved by the Texas State IRB on May 22nd 2019. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB chair, Dr. Denise Gobert 512-716-2652 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

APPENDIX D – Survey

Injury History Form

Name:_____ Date:_____

Ht._____ Wt._____ Age:_____ Sex:_____

Ethnicity/Race (circle one): Non-Hispanic White Non-Hispanic Black

Asian American Mexican American Other Hispanic Other

Class Rank: Graduate Undergraduate High School

1. Are you currently on a dance team? Yes No
2. How many years have you been dancing? _____
3. What is your predominant dance style? Jazz Ballet Tap

   Hip Hop Contemporary/Lyrical Other
4. On average, how many hours a week do you practice?_____
5. On average, how many shows do you perform in a season?_____
6. Please list other dance styles you practice regularly.

   _____

   _____

   _____
7. Have you had a dance-related injury in the past year? Have you had a dance-related injury in the past 5 years? Injury defined as "injury sustained in practice or performance"

   _____

   _____

   _____
8. Were you seen by a medical professional for any dance related injury(s)? If yes, please explain.

   _____

   _____

   _____

   _____

   _____
9. Were you removed from participation for dance-related injuries? If so, how long?

   _____

   _____

   _____
10. Have you ever been diagnosed with an eating disorder or female athlete triad?

    _____

11. What is your level of physical activity outside of dance? (Circle one)

Very Little	Some	Moderate	High	Vigorous
1	2	3	4	5

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