PREVENTATIVE FUNCTIONAL SCREENING IN UNIVERSITY DANCERS: CONSIDERATIONS FOR AN EVIDENCE-BASED TRAINING PROGRAM

A THESIS

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"Focus on the journey, not the destination. Joy is found not in finishing an activity but in doing it."
-Greg Anderson

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INTRODUCTION

The dancer is involved in a unique sport with specific artistic and aesthetic demands.[1] Due to the physical nature of dance, a dancer walks the fine line between being an artist and an athlete.[2] Dance is viewed as a form specific sport, focusing on the style and how aesthetically pleasing a motion is completed rather than completing a motion to score a point or goal.[1]

It is important to understand the physical demands placed on a dancer to better direct the dance medicine staff's efforts in proper care of a dancers injuries and overall health. Peer et al[2] suggest that injury prevention should be the main focus of the dance medicine team. Without understanding the demands, strengths, and limitations placed upon a dancer, an injury prevention program would be difficult to develop.

Research in dance medicine has been inconsistent; this has resulted in the lack of consensus and adoption of universal standards for an injury definition, injury prevention screen, and an injury reporting system.[3] Incident of injury has been collected on several forms of dance;

however, these studies have mainly been self-reported by the dancer. This leaves the interpretation of an injury up to the dancer. As a result, even if a dancer is given a definition of an injury within the context of the research, it may be unclear of how to rate the severity of the injury because of difficulty recalling the injury. Ojofetimi et al[4] limited collecting information on the injures reported by a dancer to within the previous 12 months to reduce recall bias as research has shown that recall accuracy declines with time.

To effectively reduce dance injuries, a reporting system that is consistent and systematic is necessary.[5] The clear and consistent definition of an injury is a critical part of the success of any injury reporting system. There are two main ways to classify injuries either time-loss or function-loss. Many non-time lost injuries can be as common or more common than time lost injuries.[6] Weigert et al[7] defines an injury as any problem that caused pain and/or limited participation in a dance activity. Bronner et al[8] defines an injury as any physical complaint sustained by a dancer resulting from performance rehearsal or technique class. Injury is further delineated in the following ways: (1) physical complaint injury – able to perform full activity but feels restricted, (2) medical injury –

requires medical attention beyond triage, (3) time loss injury – results in a dancer being unable to participate in future performance, rehearsal, or class, and (4) financial injury – medical injury that results in financial outlay. In this definition, each injury is also coded by severity, injury type, location, tissue, activity, and style of dance and choreography. In this way, this injury definition addresses the issue of having to code injuries by either time-loss or function-loss by combining the two ways to define an injury creating a multi-factorial injury definition.

To have an effective injury reporting system, there must be an effective baseline measurement of the dancer. Objective data collection by use of a functional screen assessment will contribute to injury prevention efforts by understanding intrinsic risk factors.[9] Other injury reporting systems used in sports are the National Collegiate Athletic Association Injury Surveillance System (NCAAISS) and the National Athletic Injury Reporting System (NAIRS). Both mainly collect injury incidence and define injuries upon time-loss, which is not as comprehensive as the suggested reporting system by the dance medicine community.[5] The NCAAISS and the NAIRS do not have a recommended functional screen that would help assess

intrinsic risk factors and establish baseline results for athletes prior to injury. An injury surveillance system and a preventative functional screen can provide information about where to focus prevention efforts[5] and can provide a thorough examination of intrinsic and extrinsic risk factors that may influence injury, thus providing a cornerstone of understanding and planning to conditioning.[9]

Also used in athletics, the pre-participation exam (PPE) typically addresses major health concerns or injuries which may be life-threatening to the athlete.[10] The orthopedic exam often included in the PPE is brief and not specific enough to address micro strengths and limitations which may influence training programs or injury prevention efforts. The dance medicine community has suggested a functional screen be administered to dancers to better understand where to focus injury prevention efforts.[9] The functional screen is recommended to use on the specific population of dancers by Marijeanne Liederbach, PhD, ATC, PT, CSCS; the screen includes aspects of general fitness, flexibility, body composition, cardiovascular endurance, gross muscular strength, range of motion, postural symmetry, foot biomechanics, and functional movements specific to dancers.[5] When comparing the components included in the PPE and a functional screen it is clear how much

more in-depth the functional screen looks at a dancer, and, as a result, could provide valuable information to assist the allied health care professional in providing injury prevention care.

Ultimately, there is an indefinite amount of possible functional screens to use. However, the screen published by Liederbach in 1997 and revised version published in 2004 is one of the few published functional screens specifically designed for dancers. Injury prevention screening has immediate, and potentially long-term benefits for dancers.[11] Identifying medical or musculoskeletal conditions that may predispose the dancer to injury could play a role in enhancing a dancers movement patterns, leading to more efficient and effective performance.[12] Making sure we implement an evidence-based training program in a dancers regime after performing the functional screen and analyzing the information is paramount. The injury prevention efforts will allow allied health care professionals to better understand the unique sport of dance and the injuries specific to dancers. The purpose of this study was to identify a functional injury prevention screen that could be used to provide a framework from which to develop an evidence-based training program that could be used by

practitioners to reduce the potential of injury and enhance performance of dancers.

METHODS

This section includes the following subsections: research design, subjects, instruments, procedures, hypotheses, and data analysis in addressing the purpose of the research.

Research Design

This study used a qualitative research design in which an evidence-based training program was developed by using the components of a screen for functional capacity in dancers. Data was collected on university dancers by using the Preventative Screening Form (developed by Marijeanne Liederbach, PhD, ATC, PT, CSCS, Director of Research and Education at Harkness Center for Dance Injuries). Results of the dance screen were then organized into an Excel spreadsheet and used to systematically identify errors to create a profile. The profile was then used to determine an appropriate training protocol. Results should be applicable to most clinical applications as the training program is evidence-based in rehabilitation practices used by certified and licensed clinicians, particularly for the

university level dancer participating at similar demographic institutions.

Subjects

The participants selected for this study were dancers with 5 years or more of formal dance training, which is defined as private studio, pre-professional company, and/or university instruction. The sample of participants was selected by convenience and experience. All participants were currently enrolled in a dance class at California University of Pennsylvania, and/or were classified dance minors who were actively participating and performing. There were 13 participants that met this criterion to be screened for functional capacity. Volunteers were addressed after approval by California University of Pennsylvania's Institutional Review Board. The participants were addressed during dance classes and/or rehearsals during their performance season, without the presence of the dance instructor/choreographer. The dance instructor/choreographer was the one faculty member that was asked not to speak with and invite dancers into the research study. This was done to ensure the instructor/ choreographer did not influence the dancers' participation.

An Informed Consent Form (Appendix C1) and Subject Information form (Appendix C2) were completed by the participant prior to the researcher administering each dance screen.

Instruments

A Subject Information form (Appendix C2) and the Preventative Screening Form (Appendix C3)(developed and then revised in 2004 by Marijeanne Liederbach, PhD, ATC, PT, CSCS, Director of Research and Education at Harkness Center for Dance Injuries) were utilized in this study to screen the dancers. The original screen for functional capacity was published by Liederbach in 1997[4] (Appendix C4) was not used. Other devices that were required to administer the screen were: one measuring tape, a universal goniometer, Lafayette hand dynamometer, bench step 20 inches for step test, and an inclinometer. The screen performed on each dancer was timed to create an average of time needed to perform the screen. The preventative screen was administered in the order on the form; assessing gross posture and motion, flexibility/range of motion, manual muscle testing strength, and lastly functional strength and skills tests. The Harvard Bench Step Test, which is listed

last on the screen, was performed first as a warm-up as suggested by previous research performed at Harkness. The detailed outline of the screen can be found in the procedures section. The majority of the tests procedures performed on the screen can be found and described in an orthopedic assessment book.[14- 17]

The researcher, a certified athletic trainer, administered the screen and was qualified to perform all tests and observations within the screen. The components within the screen were scored by either an average, positive or negative identification, or scored by bilateral comparison of range of motion within each test.

Preventative screening instruments are typically administered by certified and/or licensed health care professionals such as athletic trainers as standard tests that assess potential strengths and limitations of an athlete; in this case, the dancers are considered athletes but not acknowledged by the NCAA as such. All tests and observations in the functional dance screen fall within the scope of practice for a certified athletic trainer, and did not involve physical exertion beyond a normal dance class.

Procedure

After approval of the California University of Pennsylvania IRB (Appendix C5), the recruitment of participants began. Volunteers were solicited in the spring semester during the dance classes and/or rehearsals without the presence of the dance instructor/choreographer. In this project, data was collected by following the revised functional screen, Preventative Screening Form (Appendix C3). Each dancer was assessed individually by a certified athletic trainer in the order on the screen, except the Harvard Bench Step Test was performed first as a warm-up. There were a number of tests, but combined, they did not exceed the length of a full dance class, which is typically 60 to 75 minutes, and the dancer could rest at any point needed.

The first part of the screen for each individual was the Harvard Bench Step Test assessing for cardiovascular fitness; the dancer steps up and down on the platform (20 inches) at a rate of 30 steps per minute, for five minutes or until exhaustion.[14] Then assessment of gross posture and motion of the upper extremities and lower extremities was evaluated and measured. An active four scapular motion test was performed; the dancer actively flexed, extended,

adducted and abducted the arm at the glenohumeral joint, looking for abnormal scapular patterns. Iliac crest height was measured for symmetry bilaterally.[15(p623)] An inclinometer (Scoliometer) was then used to asses if the dancer has any lateral shifting in the spine.[16(p107)] In the foot, calcaneal eversion was measured with a goniometer. The "number of toes" sign was assessed by indicating from the posterior view how many toes were lateral to the calcaneus. Then the pes line test(navicular drop test) was performed.

Then, identifying the foot type was observed.[15(p865)] A forward bend test, backward bend test, and march test was performed while the evaluator looked at sacroiliac joint motion, the full explanation of these tests can be found in orthopedic evaluation books.[15(p626-629,636)] General posture was assessed from the frontal and sagittal plane; identifying if the dancer had forward head,[15(p142)] forward shoulders,[16(p223)] kyphotic, [16(p223)] flat back,[16(p227-228)] or a sway back.[16(p227-228)] Genu recurvatum was measured with a goniometer to conclude this section of the screen.[15(p735)]

Flexibility and range of motion was then assessed in the lower extremities. The dancer was sitting and was evaluated to see if they could dome their foot. The dancer was asked to dome their foot while sitting to display control over intrinsic foot muscles, sliding the MTP joints

back and up wile keeping the toes long. A modified Beighton test was performed to assess if the dancer was tight or loose in the thumb to thumb, toe touch,[16(p174,102)] lotus(butterfly), and HAD straddle stretches. A dancer's Thomas test was performed to assess if the dancer was tight or loose in the psoas,[16(p376)] rectus, [16(p376)] ilio tibial band (ITB),[65(p396-397)] and sartorius[16(p380)] stretches. Hamstring flexibility,[16(p384-386)] active open chain dorsiflexsion,[15(p873)] passive subtalar joint eversion,[15(p875-879)] and passive great toe dorsiflexion[15(p875-879)] were measured supine and/or prone using a goniometer. Active plantar flexion was observed for symmetry.[15(p873)] The dancer was then assessed to see if the Thomasson sign was present. The Thomasson sign is when the dancer is asked, while sitting, to actively dorsiflex the great toe in ankle plantar flexion and dorsiflexion, testing for a tight flexor hallucis longus. Hip internal and external range of motion were measured prone using a goniometer.[15(p667)]

Manual muscle testing was conducted by using a hand held dynamometer, which tests maximum strength by having the dancer contract the muscle groups being assessed for three seconds, the lower extremity and upper extremity were both tested. The dancer's strength was tested twice for each action and bilaterally. For manual muscle testing the

dancer was positioned sitting, prone, or supine. Using the Kendall textbook for manual muscle testing, terminal hamstring, [16(pg418)] hip abduction, [16(p426-427)] hip adduction,[16(p426-427)] hip flexion,[16(p422)] and shoulder abduction[16(p315)] were assessed.

Lastly, the functional strength and skill tests section duplicates many motions seen in normal dance training while allowing the clinician to evaluate movement patterns and functional biomechanical alignment. A Kendall supine double strait leg lowering was performed.[16(p213)] Standing turnout and disc turnout was measured in degrees, the difference was then calculated between the two measurements. A first position relevé was performed by the dancer, the evaluator looked at the pelvic girdle for control assessing for a neutral position and if the calcaneal midline and middle of the patella were aligned with the 2nd ray. Calcaneal height symmetry was compared bilaterally. A first position parallel plié was performed by the dancer specifically looking to see if the plumb line was aligned with the patella and the first and second toe tips. A second position progression was performed by the dancer, the angle of knee was assessed by identifying if it was aligned over the second toe and a neutral pelvic girdle position was maintained. Balance was assessed by using

Rhomberg test[17(p566)] and a single-leg strategy test. The single-leg strategy is the non support leg does not touch the support leg and the arms are crossed and eyes closed, assessing to identify where the dancer moves to gain balance(ankle or hip). Twenty-five heel raises in neutral parallel first position was then performed; the evaluator looked for the dancer to maintain full heel height over the first and second toe without knee flexion. Five single leg bench step-downs from 20 inches with eyes open, then closed were assessed. The evaluator looked to see if the dancer maintained the patella centered over the 2nd ray. The dancer performed five demi pliés on one foot while the trunk was pitched forward in the arabesque position. The evaluator was looking to see if the dancer maintained lower extremity alignment and balance. Five pushups in a plank position, which demonstrated trunk control was performed. The dancer then completed five front planks to five right and left side planks and was assessed for functional trunk control. The inverted planks are mainly for breakers and/ or hip-hop dancers, this test was not performed. Jumping was assessed by height when the dancer performed a parallel single leg "sauté" (jump in place) and by distance in the parallel single leg "jeté"(leap from one place to another. Each

participant's identity remained confidential and was not included on the functional screen or in the data analysis.

Hypotheses

The following hypotheses were based on previous research and the researcher's intuition.

1. The dance screen will provide a framework from which to develop an evidence-based training program that can be used by health care professionals to reduce the potential of injury and enhance performance.
2. The screen for functional capacity will be a time effective tool to use on dancers when compared to other screens performed in athletics.

Data Analysis

Data, as tests and observations in the dance screen, was collected from the Preventative Screening Form 2004(Appendix C3). This data was organized into an Excel spreadsheet to be able to systematically identify the areas of strengths and weaknesses as tested by the screen such as posture, flexibility/ range of motion, strength, and

functional strength and skills. The measurements gathered in the screen created a profile of a Division II university dancer. The raw data was observed and flagged for occurrences in the screen where, on average, the dancers failed to meet the criteria set forth on each individual special test. When a percentage of the dancers failed to meet the criteria from the screen tests, those areas were considered a global issue or error.

Evidence-based exercises that addressed the global issues and dysfunction within these areas were recommended based on the profile. To assess time effectiveness, the average length of time it took to administer the screen was calculated and compared to similar functional screening devices used in athletics.

RESULTS

The purpose of this study was to identify and use a functional injury prevention screen to provide a framework from which to develop an evidence-based training program that can be used by practitioners to reduce the potential of injury and enhance the performance of dancers. The following section contains data collected from the Preventative Screening Form (Appendix C3) for dancers. The information collected was used to create a profile of what a typical Division II dancer might look like. This section is divided into three subsections: demographics, hypotheses testing, and additional findings.

Demographics

Participants used in this study (N=13) were volunteer Division II dancers from California University of Pennsylvania. The participants were thirteen females ranging in ages from 18-23, with an average age of 20 years old (SD=1.66). All participants had at least 5 years of formal dance training, defined as private studio, pre-professional company, and/or university instruction. Participants were currently enrolled in a dance class

and/or were dance minors who were actively participating and performing. Dancers were screened during their performance season. The participants ranged in having 5-19 years of experience with an average of 14 years experience (SD=4.25). The majority of the participants training occurred in a private studio setting, with minimal training at the university level. Only one dancer had limited experience dancing for a pre-professional company. The majority of dance training the participants received was in jazz, ballet, and tap dance. Table 1 lists the types of dance training.

Table 1. Division II Dancer's Frequency and Type of Dance Training

Frequency of Dancers	Type of Dance Training
12	Jazz
11	Ballet
10	Tap
5	Modern
4	Lyrical
3	Hip-Hop
1	Contemporary
1	Ballroom

Hypotheses Testing

Hypothesis 1: The dance screen will provide a framework from which to develop an evidence-based training program that can be used by health care professionals to reduce the potential of injury and enhance performance.

Conclusion: To test the hypothesis, each special or functional test results were organized into an Excel spreadsheet as raw data (Appendix C6) which was then systematically flagged for errors and/or issues. If more than 45% or 6/13 of the participants failed to meet "normal" criteria, this data was flagged and used to create the profile of Division II dancers' potential weaknesses. The percentage 45% was determined by the researcher as this was almost half of the participants displaying errors in the specific test. The special and functional tests that 45% of the participants failed to meet normal criteria are listed in Table 2.

Table 2. Profile of Weaknesses in Division II Dancers

Test on Preventative Screen	Amount of Participants who Failed the Test	Observation
Calcaneal Eversion≥ 4	8/13 R foot 6/13 L foot	Scored <4°
Dome Foot	8/13 R foot 7/13 L foot	Poor control of intrinsic foot muscles
Lotus Stretch	9/13 tight bi	Not able to get appropriate ER at hip
ITB	7/13 tight R 10/13 tight L	Tight abductors
Hamstring	8/13 tight R 9/13 tight L	Scored <120°
Active open chain dorsiflexion	6/13 R foot	Scored ≤ 5°
Passive great toe extension	7/13 R great toe 6/13 L great toe	Scored <90°
Thomasson Sign	12/13 R great toe 12/13 L great toe	Tight flexor hallucis longus
HER prone	11/13 R hip 11/13 L hip	Passive ROM <45°
HIR prone	6/13 R hip 6/13 L hip	Passive ROM <45°
Hamstring MMT strength	Avg 85% bilateral difference	More than 10% difference bilaterally
Hip Abductor MMT strength	Avg 10.6 lbs R 10.6 lbs L	Normative 14.6-15.5 lbs
Hip Adductor MMT strength	Avg 10.2 lbs R 9.8 lbs L	Normative 14.8-15.6 lbs
Hip Adductor MMT strength	Avg 89% bilateral difference	More than 10% difference bilaterally
Hip Flexor MMT strength	Avg 12.2 lbs R 13.4 lbs L	Normative 20.2-24.4 lbs
First position relevé	6/13 R 6/13 L	Poor alignment- Calcaneal midline & mid patella medial to 2nd ray
Second position	9/13 R leg 6/13 L leg	Poor alignment – knee grossly medial to 1st ray
Second position	7/13 L leg	Poor alignment – knee just medial to 1st ray
Single leg strategy	7/13 R leg	Unable to stabilize at ankle, used hips
Step down eyes closed	8/13 R knee 9/13 L knee	Unable to maintain patella centered over 2nd ray
5 pushups	6/13	Lost trunk control
plank→ side plank	13/13 R 13/13 L	Lost trunk control

After the profile of weaknesses was created from the preventative screen's raw data, the profile was systematically reviewed and flagged for trends in failed special and functional tests. If the profile identified two or more failed tests in anatomical areas, the researcher considered this to be a global issue or error. This screen mainly examined the trunk and lower extremities; the few tests screening the upper extremities did not have more than 45% of participant fail to meet normal. Anatomical areas presenting errors were divided into trunk, hips, and lower extremities. Dividing the global issues into general anatomical areas allowed the researcher to identify corrective exercises to address the global issues. Corrective exercises for the evidence based training program were developed using the National Academy of Sports Medicine (NASM) Essentials of Sports Performance Training,[14] Harkness Center for Dance Injuries website,[18] and functional dance exercises. Pictures of some of the exercises are shown in Corrective Exercise Pictures (Appendix C7). Corrective exercises addressing the global errors and observed weaknesses are listed in Table 3.

Table 3. Observed Global Issues and Corrective Exercises

Anatomical Areas	Global Issues Observed	Corrective Exercises
Trunk	-Poor core functional stability & strength	Planks, pike sit-ups, side planks with hip abduction, single leg balance progressions (working up to eyes closed and arabesque), lunges, Swiss ball progressions (plank, crunch, roll away), double leg wide squat control of core
Hips	-Tight hip ER -Tight hamstrings -Weak hip ER -Weak hip flexors -increase Hamstring strength and equalize bilaterally -Improve hip Abd/Add strength(gesture leg strength)	PNF stretch deep hip ER/hamstrings , standing single leg hip extension and flexion and Abduction (working on gesture leg control and strength), single leg balance/ reach progressions, second position plié (double leg wide squat) with correct alignment of knee and 2nd ray and pelvic girdle) and progression to plié to sauté (polymeric training), self-myofascial release ITB
Lower Extremities	-Poor alignment of knee and 2nd ray functionally and passively -Tight flexor hallucis longus/ limited great toe dorsiflexion -Poor functional ankle stability	Demi-plié parallel with alignment over 2nd ray, progress to 1st /2nd position relevé and plié, PNF stretch great toe, single leg balance strength progressions/ single leg hop progressions

Hypothesis 2: The screen for functional capacity will be a time effective tool to use on dancers when compared to other screens performed in athletics.

Conclusion: To test the hypothesis, each participant's preventative screen was timed. The timer started when the practitioner started the preventative screening form and not during paperwork prior to the screen. It took an average of 41.5 minutes (SD=7.73) to complete the screen for each individual. This preventative screen is a comparable and an effective tool to use on dancers when compared to other screens performed in athletics. This screen was identified as effective because of the valuable data it provided on each dancer. There are many variations to any screen, thus determining time it takes to complete PPEs, orthopedic exams, and/or National Academy of Sports Medicine (NASM) sports performance testing will vary depending on the clinician. The researcher has had experience with administering orthopedic exams, NASMs sports performance testing, and assisting with PPEs. It has taken the research approximately 15-45 minutes to perform an orthopedic evaluation, depending on the injury. To perform NASMs sports performance testing it has taken 30-50 minutes, depending on tests chosen to include. When assisting with administering a PPE it approximately took 20-30 minutes in a family physicians office. Table 4 illustrates the average time it took the practitioner to complete the screen for each participant.

Table 4. Amount of Time to Complete the Preventative Screen on Each Participant

Participant #	Time in Minutes
1	55
2	52
3	53
4	45
5	38
6	40
7	45
8	39
9	35
10	32
11	35
12	36
13	35
Average	41.5
Standard Deviation	7.73

Additional Findings

Many of the special and functional tests on the preventative screen can identify issues and/or errors that did not meet the 45% criteria established in this study that warranted being flagged to include in the profile. For example, pelvic girdle dysfunction in general was not included because the occurrence was less than, but close to 45%. Collectively, 7 of 13 participants tested positive for

pelvic girdle dysfunction in one of the following tests: (1) the forward bend, (2) backward bend, and (3) march test. Of those 7 participants, 5 then failed the single-leg strategy balance test. Of the 5 participants who had iliac crest height asymmetry, 3 also tested positive for pelvic girdle dysfunction. Those 3 dancers who tested positive for spinal imbalances using the inclinometer also tested positive for pelvic girdle dysfunction.

It is clear that pelvic girdle instability affected many other aspects of the participant's performance on the screen. Pelvic girdle dysfunction is one item that must be addressed by a physical therapist and/or certified athletic trainer before starting corrective exercises.[16] The trunk corrective exercises and the second position plié progression can assist in developing the core muscles to potentially prevent this dysfunction form reoccurring.[14] Training in biomechanically dysfunctional positions will allow poor movement patterns to become trained movement patterns and could increase risk of injury.

DISCUSSION

The following discussion is divided into three sections: discussion of results, conclusions, and recommendations.

Discussion of Results

This study was designed to identify a functional screen that would provide a framework to create a profile of a Division II dancer. A corrective, evidence-based training program could then be created from the profile and used by practitioners to potentially reduce risk of injury and enhance performance. The results showed that the Preventative Screening Form used for this research could be used to create a profile of a Division II dancer, and subsequent corrective exercise program.

The profile identified many weaknesses in these dancers that may lead to injury. As many dance minors do not have a skill test or any qualifications before entry into a dance class or the minor, early training is crucial for proper alignment and musculoskeletal control. As most of the dancers in the current study indicated that most of their years of experience were provided in private studios,

quality of instruction there should be a focus. Private studio dance teachers need to have proper education in dance and movement science, specifically kinesiology, anatomy and physiology, as well as having the skills to identify poor alignment in basic dance positions. Correcting these malalignments at an earlier age could decrease the amount of limitations presented on later functional screening, reduce potential injury, and increase the longevity of the healthy dancer.

The dance medicine community suggests that screening and thoroughly evaluating dancers for predisposing issues that may contribute to injuries is critical.[2,3,9] A PPE, which is typically the most basic form of screening used in athletics, is not designed to address the micro strengths and weaknesses as well as a functional screen. While there are many functional screens used in general athletics, creating and implementing a functional screen that is adjusted to look at this specialized population can be overwhelming. The Preventative Screening Form (Appendix C3) used in this research study is one of many possibilities, and provided a comprehensive profile of strengths and weaknesses of the dancers. Incorporating a variety of special tests and functional skill tests allowed for an in-depth profile of each dancer.

It was suggested by Potter et al[12] that a functional screen can help detect musculoskeletal conditions that may predispose dancers to injury. The functional screen used in this research allowed the researcher to identify weaknesses in the screened dancers, which can potentially be modified to assist in injury prevention. The profile created from the screen identified global errors and malalignments in the lower extremities and core, with limited tests for upper extremity. In the lower extremity, the patella was medially aligned to the second ray in 46% of the participants in the first position relevé and second position as opposed to the correct alignment. It is important to identifying malalignments that can cause movement impairment syndromes predisposing the dancer to various injurys.[19] The profile identified that 85% of the dancers had less than 45° of hip external rotation, which may have led to poor alignment of the knee during first and second position. If this is seen in other dancers screened, assessing hip extension and external rotation strength would be beneficial to understanding the cause of this issue. Limited hip external rotation indicates that these dancers are using compensatory strategies to gain motion at the hip, which may put them at increased risk of knee injuries.[20] By planting their feet at the desired angle of

turn out, the functional Q-angle is increased at the knee and can predispose the dancer to valgus stress and patellofemoral syndromes.[21] It should also be noted that ballet was not the primary training method, and that more instruction was provided in private studios where instructor education and experience in alignment and functional kinesiology may be limited or absent completely.

Poor functional core stability was also observed; as 100% of the dancers failed to stabilize during 5 plank to side planks and 46% failed to stabilize during 5 push-ups. With low back injury incident rates ranging from 8% - 23% of all injuries dancers are incurring, [14,20,22-26] improving core stability and restoring functional movement patterns could potentially reduce the amount of low back injuries.

The functional screen identified an issue that was seen in some but not all of the dancers and should not be overlooked by health care practitioners, pelvic girdle dysfunction. The pelvic girdle is the building block for efficiently distributing weight, absorbing forces, and transferring forces to maintain the dancers' center of mass over a constantly changing base of support.[14] The dancers who tested positive for pelvic girdle dysfunction in the forward bend, backward bend, or march test also displayed other errors on the functional screen. Proper pelvic girdle

alignment and function is important to maintaining normal length-tension relationships, if not dysfunctional movement patterns may predispose the dancer to hamstring injuries.[15] The pelvic girdle works as a unit to produce force and stabilize isometrically against abnormal compressive, torsional, and sheer forces.[14] If the pelvic girdle is unable to stabilize properly, this may contribute to low back pain and potential low back injuries. Without the pelvic girdle properly functioning the athlete/dancer may inefficiently transfer forces through their body, decrease dynamic stability and movement of the femur, and may lead to predictable patterns of injury.[14]

As balance is a key requirement to the participate in dance, dancers exhibiting pelvic girdle dysfunction may demonstrate less efficient and effective stabilization strategies on one leg.[14] Of the 7 dancers displaying pelvic girdle dysfunctions, 5 failed the single leg strategy test. In the 3 participants who had spinal imbalances a pelvic girdle dysfunction was also seen, weather this is stemming from the spine or pelvic girdle is unclear. However, correcting the issue if possible is one way to decrease risk of injury and minimize training in dysfunctional biomechanical alignments. Training with proper postural control decreases the risk of developing muscle imbalances

and joint dysfunctions that predispose the dancer to an array of issues.[14] Correcting biomechanical issues or malalignments is vital to aiding in injury prevention and performance enhancement.

The profile created from the screen was used in identifying corrective exercises to address the global errors seen in this population. The literature suggests screening can help direct injury prevention efforts,[20,26] can assist in understanding injuries, and how we plan in regards of dance conditioning.[8,9] Implementing a corrective exercise program after screening dancers is potentially where health care practitioners will see improvements in decreasing the amount of global errors. Ideally, creating an exercise program to aid in correcting all weaknesses displayed in the profile would have the greatest effect on reducing risk of injury. How such training fits into the already physically active and time demanding training is uncertain. In general, people can remember 4-5 tasks. Thus, creating 4-5 functional movements that address correcting a majority the global issues could prove beneficial due to time concerns. These functional movements could easily be adapted into the warm-up of a dance class without disrupting the culture of dance training. Table 5 lists 4

key exercises identified by the researcher as a start to addressing the global errors.

Table 5. Four Key Corrective Exercises

Key Corrective Exercises
-Swiss ball exercises (plank, roll away)
-Second position plié (double leg wide squats) (correct alignment of knee, 2nd ray, and pelvic girdle) (progression to plié hold and plié to sauté) (progress from stability, strength and then polymeric training)
-Standing single leg hip extension and flexion (working on gesture leg control and strength) (control pelvic girdle)
-Single leg balance/ reach (strength/ single leg hop progressions)

The profile displayed many issues that could be addressed by several individual corrective exercises. The key corrective exercises were identified by if the exercise could address several global issues. The specific progressions were left to the health care professional implementing the corrective exercises, as each dancer will progress at a different pace. Many dancers failed to have functional core stability or strength, the Swiss ball exercises were chosen to develop stability in the core and pelvic girdle.[14,18] A second position plié with focus on correct alignment was chosen to help develop functional core, hip flexors, and hip external rotators strength. Standing single leg hip extension/ flexion exercises were chosen to help develop core, pelvic girdle, hip extension/

flexion strength during functional movements as well as improve balance on the support leg.[18] A single-leg balance/ reach progression was chosen to develop neuromuscular efficiency in the lower extremity as well as improve core and pelvic girdle strength during functional movements.[14,18] Performing only these corrective exercises daily could start to address some of the global issues seen in the dancers.

There are many exercises that could have been included into the corrective exercise program. The researcher suggested the exercises based on the global issue observed and known exercises that would target the issues. Understanding that the heath care practitioner would need to utilize their knowledge of progressions (stabilization, strength, power) to properly implement the training program is important. The focus of every exercise should be correct form and alignment, if needed the exercise should be modified to allow for this. Strength training is often negatively viewed by dancers because of specific aesthetic requirements. However, no evidence has indicated that strength training would negatively affect flexibility or aesthetic requirements.[1,27] Tailoring the corrective exercise program to these unique athletes while addressing the

global errors was the main focus when suggesting the exercises listed.

Injury prevention is a multifaceted concept it encompasses addressing two main factors, extrinsic and intrinsic risk factors.[4] Injury prevention can be an overwhelming and difficult task, but by addressing the factors we can control this one way we as the dance medicine community can meet the recommendations of having our main focus on injury prevention.[11] If we approach injury prevention by implementing appropriate PPE for a dancer by implementing a functional screen, creating a profile to identify global issues, and then implementing 4-5 corrective functional movements to address intrinsic risk factors, we may be able to significantly reduce the risk of injury. Although controlling and limiting extrinsic risk factors is a task we may or may not be able to change, addressing one of the main factors will be a solid start to addressing this difficult task. Other implications, secondary to the research purpose, point to dance training which may not have addressed the noted dysfunctions exhibited in approximately half of the dancers. Focus on physical training, corrective exercise, and the use of certified health care and/or fitness professionals in

private dance studios may aid in reducing such dysfunctions and enhance performance overall.

Conclusions

Using the functional screen was an effective tool in identifying strengths and limitations in the dancers. Global errors can be taken from the screen's test results with corrective training exercises developed for individual dancers that could potentially reduce the risk of injury if properly treated by a physical therapist/ certified athletic trainer. Identifying 4-5 exercises that functionally target many of the global issues would be ideal for health care practitioners and allow for ease when suggesting application to the dance instructor or dancer, and could be used with any dancer with similar demographics and profile.

Recommendations

This study established a profile of strengths and weaknesses of Division II dancers at one university. Similar studies should expand on creating profiles of dancers at other universities with similar or different

demographics. Understanding the differences among university, youth, and professional dancers could assist in developing what injury prevention efforts need to be implemented at each level. This would allow the researcher to identify if the global issues found in these university Division II dancers are global issues of dancers across various levels of dance and/ or experience.

Additionally, future research should include a more in-depth injury and training history. Ideally, using the data collected from the functional screen with an injury surveillance system would provide the most comprehensive profile of a dancer. The dance medicine and science community is currently in the process of addressing this issue.[5] Private studios might benefit form in-studio services with a certified health care professional in using screens earlier in a dancer's career and implementing subsequent corrective exercises.

Implementing the corrective training program and re-screening the dancers is recommended to see if the training program reduced the global errors. This may provide confirmation that the dance medicine community is headed in the correct direction for injury prevention efforts. The functional screen showed to provide valuable information on this population. After the data has been collected,

implementing the corrective training program could be the most important step to reducing risk of injury and enhancing performance in dancers.

Currently there is no standard for time needed to perform screens. In future research determining if the functional screen used in this study is a time-effective tool when compared to another form of a functional screen would be helpful. This inconsistency of non-uniform screening has been well documented in the sports medicine and dance medicine community.[10,28]

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APPENDICES

APPENDIX A

Review of Literature

REVIEW OF LITERATURE

In the performing arts, dancers are known to have injury incidence across all forms of dance. With certified athletic trainers working in several dance settings, it is important to understand the needs of this special population.[1] Athletic trainers specialize in the prevention, diagnosis, treatment and rehabilitation of injuries and illnesses in physically active people.[1] If the allied health care professions could create a standardized screening tool that is used to asses strengths and limitations of dancers, a decrease in injury rates could potentially be observed. Analyzing the various injuries that occur in dance and what screening tools can prevent these injuries will help keep dancers healthier and injury free. The purpose of this review is to enlighten the reader on the importance of the current Pre- Participation Exams, understanding the dancer as an athlete, and potential functional screening tools tailored to dancers.

Pre-Participation Exams in Sports

A typical pre-participation exams (PPE) required for participation in other sports is not targeted to assess micro-strengths and limitations for injury performance,

rather it is focused on medical history.[2] The purpose of the PPE is to screen for any major health or cardiovascular abnormalities which may prevent the athlete from any pre-existing condition that may be life-threatening. There is a brief orthopedic section asking about previous injuries to see if there are any prior injuries that would prevent them from safe participation in sports.[2] There is limited research regarding the best practices for a PPE, even though the PPE is a nationwide requirement for most sport organizations for participation yet there is no standard protocol.[2] The screen for any pre-existing cardiovascular conditions that may be life-threatening has stayed fairly consistent in asking about family and personal history, progressing to an electrocardiogram (ECG) or stress test if the athlete has a family history or abnormal heart beat. However, the American Heart Association (AHA) has not recommended mass ECG and stress testing as conflicting evidence has been reported on the sensitivity of these tests detecting life-threatening cardiovascular conditions, specifically sudden cardiac arrest. There is no functional screen required to be included in a PPE, yet there are many functional screens being utilized across the country.

There has been little information reported on PPEs given to dancers prior to participating. Dancers do need a

PPE for participation mainly focusing on a general health history and brief orthopedic exam; however, the orthopedic exam and functional screen need to be properly adjusted to look at this specialized population more in-depth. The PPEs are the most widely used form for injury prevention, but the orthopedic exam is not specific enough to address micro musculoskeletal limitations that may put the dancer at risk for injury which suggests the need for a functional screen. Depending on the type of program the dancers are associated with, they may or may not have the opportunity to receive an orthopedic exam or a functional screen prior to participating in the dance class. The need for a comprehensive functional screen and an injury surveillance system in dance has been well documented; still the possible methods for creating and implementing each are unlimited.[3] In 2004, the International Association for Dance Medicine and Science (IADMS) research committee began a project to adopt a uniform testing and reporting method. The first step this committee saw necessary was to analyze screening form items and methods currently used to screen dancers they collected 68 forms from 13 countries. This process of identifying important components of the functional screen currently used by allied health care professionals is potentially a step towards adopting a

uniform functional screen. The screening process can be very time consuming, yet the study done by Allen et al[4] showed that the screen assists in the ability to predict and prevent injuries in dance company members.

The Dancer as an Athlete

An abundance of information has been collected on incidence of injuries in dancers, which have indicated that even though dance is not a competitive sport, the physical demands they endure are as potentially traumatic as those other athletes' face.[5] Nicholas et al[6] assessed 61 sports and activities in three categories: neuromuscular, psychometric, and environmental factors. Ballet ranked second behind football as the most demanding of all sports and activities.[6] The article received criticism after it was published because after 1975 the ability to objectively measure motor skills between sports advanced tremendously. More importantly, Marijeanne Liederbach suggests dancers are unique athletes.[5] In each movement a dancer performs, athleticism and art is combined. In most traditional team sports, how an athlete performs a motion does not matter as long as the goal or point is scored. While we see form-specific individual sports such as diving, figure skating, and gymnastics, in dance, every motion adds to the

performance and how the dancer executes each movement is just as important as the motion. This creates a fine line that a dancer balances which is not seen in many other sports. A dancer requires specific training that does not interfere with the artistic and aesthetic requirements.[7]

Dance Training

Dancers have specific aesthetic requirements that have limited their training in the past. Recent studies have showed that certain strength and cardiovascular training will reduce risk of injuries and may not interfere with the aesthetic appearance of a dancer.[7,8] Recent data is showing that supplementary aerobic activity and muscular training may reduce injuries in dance.[8] There is no evidence indicating that strength training negatively affects flexibility, which often may be a reason dancers avoid strength training.[8] In a 12-week supplementary strength training program for hamstrings and quadriceps, authors found the program beneficial to professional ballerinas; the program did not alter selected thigh aesthetic components which is often a main concern.[7] Dancers with lower thigh muscle power outputs were found to be at an increased risk of lower extremity injuries, including ankle

injuries.[9] An increase in muscular strength may increase a career in dance. More research is needed to objectively to determine if strength training would actually increase the longevity of a dancer's career as previous research indicates.[9] Understanding what type of physical training will aid a dancer in having a strong and stable base for all dance movements without distracting from their desired aesthetic appearance can assist in providing injury prevention care.

Dancers' Most Common Injuries

There are several different types of dance such as ballet, modern, jazz, tap, Latin, hip-hop, and theatre dance (Broadway). The majority of studies regarding injury incidence have collected information specific to the ballet form of dance. Much of the information collected on injury incidence across all forms of dance is of self-reported injuries. This leaves the definition of an injury up for interpretation by the researcher or dancer, and creates conflicting result across the research. In 2006, there was still no consensus in the dance medicine community on a definition of injury.[10] In 2007, IADMS identified two main

injury definitions: (1) by time lost from activity, or (2) by function lost.[11]

In self-reported studies of injury incidence, injuries were categorized depending on the anatomical location. Some studies separate foot and ankle, whereas others combine these as one area of injury. The majority of all injuries that dancers experience across all forms of dance are in the low back or lower extremity. In ballet, modern, and Broadway forms of dance, foot and ankle injury incidence ranges from 22.5% to 48.8% of all the injuries dancers are experiencing.[12-18] Low back injury incidence ranges from 8% to 23% of all the injuries dancers experience.[12-18] Hip-Hop dancers were reporting injury rates that were higher than other forms of dance but similar to gymnastics.[19] Hip-Hop dancers spent a minimal amount of time in a warm-up and cool down, with 33% of the dancers admittedly did not warm-up prior to dancing. This has been a possible explanation for the higher rate of injuries.[20] Most injury research has been done on professional mature dancers with a reported 60-90% of dancers needing to stop performing for extended periods of time due to overuse injuries.[21] Dancers, during their pubertal growth spurt, are at a higher risk of injury.[21] More research is needed on younger dancers and injury types.[21]

Injury Definition and Surveillance

The wide range of how injuries are defined and reported has generated some recommendation for the dance medicine community to adopt uniform testing and reporting methods.[3] The reporting method was encouraged to be used by health care professionals such as certified athletic trainers and licensed physical therapists that are working with dance schools or companies. There are two systems used in collegiate sports, the National Collegiate Athletic Association (NCAA) has an Injury Surveillance System (ISS) and the National Athletic Injury Reporting System (NAIRS), and one in professional dancers, International Performing Arts Injury Reporting System (IPAIRS). However, both systems developed for collegiate sports only collect injury incidence and are not near as extensive as the one suggested to implement by the dance medicine community.[10] These systems base their injury definition on time loss and not on function loss, although the IPAIRS does allow grading of a dancers function by using a task grid.

This reporting system would create a standard of what is defined as an injury in the dance sports medicine realm. The comprehensive reporting system would be able to account

for injury occurrence, intrinsic risk factors, and extrinsic risk factors.[22] More specifically, it would also allow an understanding of what the injury was, specific anatomical location, severity of the injury, prevalence of the injury across dancers, injury outcome, what type of injuries dancers are incurring versus what they perceive their injury to be, and how to provide better injury prevention care.[10,11]

Injury Prevention in Dance

Injury prevention is a multifaceted concept that requires addressing this topic from two main directions, evaluating the extrinsic factors and intrinsic factors that may increase the risk of a dancer sustaining an injury.[19] The extrinsic risk factors are items that we as health care professionals may or may not be able to modify, but we must take into account when making recommendations to a dancer's environment to aid in injury prevention. Intrinsic risk factors are items that we can modify usually by altering a dancers training program and over time we may be able to assist in injury prevention. Potter et al[23] also suggests that a functional screen which would assess intrinsic risk factors can help detect medical or musculoskeletal

conditions that may predispose dancers to injury and/or illness during their season.

Extrinsic and Intrinsic Risk Factors

It is important to recognize extrinsic risk factors that are specific to dancers; the dance discipline, shoe, floor surface, muscle imbalances, and training regimen.[15] The type of dance discipline has been shown to vary the risk and type of injury. Dunn and Graham[24] suggest classical dancers maintain a rigid torso, and that modern dancers perform more ballistic trunk movements creating the potential for more back injuries. Another example is modern dancers mainly dance barefoot, which predisposes these dancers to unique biomechanical factors because of the type of dance they are studying.[22] The shoe, for most athletes, provides stabilization, absorbs and returns forces, and protects the skin from bruising; in dance they are often barefoot or in pointe shoes which can also distort ground reaction forces.[5] The floor is also a consideration, ideally it would be constructed from sprung wood. However, the floor is often sloped, splintering, or made from cement base.[5] Many dancers, particularly college dancers, are exposed to different surfaces in their training. This can often confuse a dancer's estimation of the spring in the

floor which could potentially cause dynamic overload throughout the kinetic chain.[24]

Identifying muscle imbalances may help identify relative weakness or limited ranges of motion the dancer may have developed from compensating movement patterns.[24] All of these extrinsic risk factors play an important role when considering changes to create a safer environment for the dancer to dance in. We may be able to or not be able to implement changes depending on the resources available.

Intrinsic risk factors specific to dancers are age, anatomical structures, and body mass index.[22] Age and maturity level of a dancer helps determine appropriate intensities of class and rehearsals for the stage of the dancer's body.[25] The knees of younger dancers tend to be at higher risk than older more trained dancers because of compensating strategies used to gain external rotation of the hip.[18] The anatomical abnormalities of structures in each dancer can cause abnormal weight-bearing loads; this can lead to primary and secondary kinetic-chain dysfunctions which are both common in dancers.[22] Research suggests that underlying injuries are subtle malalignments or anatomical abnormalities which cause movement impairment syndromes.[26] Lastly, a dancer's body mass index with excessive fat mass and decreased lean muscle tissue or a

dancer using nutritional deficiencies as an attempt to maintain leanness; both may be predisposing causes to injuries.[22] These intrinsic risk factors play an important role in limiting or advancing the training programs that will allow the dancer to dance at the appropriate intensity level based on their body.

Several studies' recommendations indicated that one of the best ways to detect potential risk factors and reveal existing injuries is through functional screening.[10,15,21,25] Since it is recommended that screening and injury prevention be the main focus of the dance medicine team,[25] screening could identify the intrinsic risk factors that possibly could influence our understanding of injuries and planning in regards of the dancers conditions.[4,10] Screening was one element of a comprehensive program that showed to reduce injury rates in both a ballet and a modern dance company.[12,26,27] Dancers with previous injuries are more likely to sustain an injury than those who have not had a prior injury.[23] Screening all dancers for predisposing conditions that contribute to injuries is a critical part in injury prevention[10] and helps direct injury prevention efforts.[17,18]

Components of a Functional Dance Screen

The functional screening tool should include components such as posture, fitness, orthopedic assessment, strength, flexibility, range of motion, biomechanics, and functional capacity activities relative to the unique training requirements of the specific sport, in this instance, dance.[29] In data collection on injuries in dance it is important to collect lateral bias information. We might have a better understanding on injuries if laterality is assessed during a functional screen and after injuries incur.[29] If a dancer is not able to complete the screen, then the clinician should look for possible proprioceptive deficits, muscular weakness or tightness, or a learned movement behavior that is not optimal for overall neutral human mechanics.[26] The screen for functional capacity for dancers created by Liederbach is currently one of the few published injury prevention screening tools specifically for dancers. It is important that the functional screen is used to detect medical or musculoskeletal conditions that may predispose dancers to injury and help them become better dancers and not as a tool for judgment.[23] This can help dancers educate themselves on the findings and work with physical therapists or athletic trainers to develop realistic strategies to address the areas they can

improve.[23] Using a functional screen in dance can have immediate and potentially long term benefits for dancers.[23]

Students in a dance kinesiology class were trained to perform a functional screen on their peers to promote wellness and education within the dance department. The screen assessed alignment (static and dynamic), functional symmetry, range of motion (passive and active), range of motion bilaterally, strength, shoulder girdle mobility, and femoral external rotation.[31] An exercise prescription phase was implemented in this study, but it was limited to four weeks. Because of this, the study suggested dancers were limited to only being able to enhance their understanding and awareness of their bodies. Wilson et al[31] recommended that screening in dance has the potential to become a vital element in education and informing dancers, it is important though that this screen is not used for evaluation or placement with in a dance program.[31]

Summary

Often the athleticism required of dancers is underappreciated, and the training dancers under-go causes common injuries and injuries specific to dancers.[22] The differences in types of dance also cause differences in

injuries.[22] It has been suggested that injury prevention should be the main focus of the dance medicine team,[22] a functional screen is an viable way to start injury prevention efforts. A functional screen should include an orthopedic assessment, strength, flexibility, cardiovascular endurance, and functional capacity relative to the unique training requirements.[29] In general athletics, there are many screens that an athlete is put through how we use this information is probably one of the most important aspects of performing a functional screen. A functional screen specific to dancers that will identify micro strengths and weaknesses to aid in injury prevention efforts,[2] this information would be very valuable to the dance medicine community. It would be most beneficial that this functional screen is performed on all dancers to identify predisposing conditions that might contribute to injures.[27]

Using a screen with a comprehensive injury surveillance system has the potential in the future to test theories[10] and help identify intrinsic and extrinsic risk factors. With much less information available on the frequency and type of injuries particularly in dancers in college and university programs[28] a functional screen would help in our understanding of these unique athletes.

APPENDIX B

The Problem

STATEMENT OF THE PROBLEM

The purpose of the study was to use a functional screen to create a profile for a Division II university dancer. Once the profile is created, an evidence-based training program was developed to help correct the limitations shown by the screen. It is important to create this profile and provide an evidence-based training program as dance training often causes injuries seen in other sports as well as those unique to dancers.[21] Understanding intrinsic risk factors is a critical step to reducing injuries in dancers and can help in identifying any predisposing conditions that might contribute to injuries.[22] Additionally, the information collected by a functional screen, identifying typical strengths and weaknesses, may aid in injury prevention efforts. This can be used to better understand injury frequency and type of injury in a Division II University dancer, which there is much less information overall in college and university dancers.[26] The ultimate goal of the functional screen and an evidence-based training program is being able to decrease the amount of injuries dancers that fit this profile may incur.

Definitions of Terms

The following definitions of terms were defined for this study:

1) Extrinsic risk factors - factors relating to type of work, exposure or duration of workload, equipment and environmental conditions.[4]

2) Formal dance training - private studio, pre-professional company, and/or university instruction.

3) Dance medicine team - health professionals, such as but not limited to certified/ licensed athletic trainer, physical therapist, orthopedic surgeon, dietitian, osteopathic doctor, general physician

4) Functional screen - A tool that is used to identify specific physical strengths, weaknesses, and biomechanical normalities or abnormalities of the dancer.

5) Injury - any physical complaint sustained by a dancer resulting from performance rehearsal or technique class. Injury is further delineated in the following ways : (1) physical complaint injury, (2) medical injury, (3) time loss injury, and (4) financial injury. Coding by severity, injury type, location, tissue, activity, and style of dance and choreography is also included.[10]

6) Intrinsic risk factors - factors relating to specific individual physical characteristics.[4]

Basic Assumptions

The following were basic assumptions of this study:

1) The functional screen is valid and reliable in identifying strengths and limitations in University dancers.

2) The subjects will be honest when they complete their demographic sheets regarding injury history and will perform to the best of their ability during the functional screen.

Limitations of the Study

The following were possible limitations of the study:

1) A small sample size of dancers with the dance experience and training needed to be participants in our study.

2) Results from the profile provided by the preventative screening form may be limited to dancers defined in this study with similar demographics.

Significance of the Study

The results of the functional screen are an important component of the injury prevention process. The functional screen created by Marijeanne Liederbach has basic fitness

aspects and an in depth functional assessment, looking beyond a basic orthopedic exam, while keeping in mind this specific and unique population. Screening for functional safety is difficult and time consuming, and in dance because its essence as an art makes this task more difficult.[28] Another aspect that adds to the difficulty of screening is the lack of objective and precisely measured ergonomic assessments of the demands of dance.[28] This functional screen will provide a profile of strengths and weaknesses that may contribute to injuries in a Division II university dancer; this is beneficial because there is limited information on this level of a dancer.[26] Developing an evidence-based training program to address these dancers' specific strengths and weaknesses, will increase the dancers, included in this study, body awareness and allow them to work on areas that may put them at an increased risk for injuries by using the best possible exercise for addressing each issue. It is important to treat the body as a whole when implementing a preventative/ corrective evidence-based training program and make sure we are effectively using the information provided by the screen. The profile that the functional screen will create and the evidence based training program are two very important aspects of preventing dance injuries while

providing quality information about where to focus injury prevention efforts.[28]

APPENDIX C

Additional Methods

APPENDIX C1

Informed Consent Form

California University of Pennsylvania

Informed Consent Form

1. Jena Hansen-Honeycutt, LAT, ATC, who is a Graduate Athletic Training Student, at California University of Pennsylvania, has requested my participation in a research study at California University of Pennsylvania. The title of the research is A Preventative Functional Screening in University Dancers: Considerations for an Evidence-Based Training Program.

2. I have been informed that the purpose of this study is to create a profile of a university dancer by using a functional screen that assesses anatomical and functional movement specifically for dancers. I understand that I must be 18 years of age or older to participate. I understand that I have been asked to participate because I have at least 5 years of formal dance training, which is defined as private studio, pre-professional company, and/or university instruction. I am also currently enrolled in a dance class at California University of Pennsylvania and/or I am a dance minors who is actively participating and performing.

3. I have been invited to participate in this research project. My participation is voluntary and I can choose to discontinue my participation at any time without penalty or loss of benefits. My participation will involve an completing a functional dance screen which includes an orthopedic assessment, flexibility testing, strength testing, cardiovascular fitness test, and a functional dance assessment. All of the functional tests are similar to activities required of me during an actual dance class. Completing the screen is expected to last about an hour which is similar to the length of a dance class. The tests I will be completing will be explained and shown to me before I will perform them by the researcher, Jena Hansen-Honeycutt, a certified athletic trainer, who will administer all tests. I understand that at any time I may take a break if needed.

4. I understand there are foreseeable risks or discomforts to me if I agree to participate in the study. With participation in a research program such as this there is always the potential for unforeseeable risks as well. These tests do impose some risk for the dancer such as an minor soreness and / or injury. To minimize the risk a certified athletic trainer, Jena Hansen-Honeycutt, will be present and the task will be explained and demonstrated prior to the dancer completing the task. This risk is less than a dancer's typical training during a typical dance class or rehearsal. During some of the test the dancer will be spotted if the test tests for balance, or if the dancer asks to be spotted.

5. I understand that, in case of injury, I can expect to receive treatment or care in Hamer Hall's Athletic Training Facility. This treatment will be provided by the researcher, Jena Hansen-Honeycutt, LAT, ATC, under the supervision of the CalU athletic training faculty, all of which can administer emergency care. Additional services needed for

prolonged care will be referred to the attending staff at the Downey Garofola Health Services located on campus.

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

7. I understand that the possible benefits of my participation in the research are to better understand my personal strengths and limitations as a dancer. I will also be taught optional exercises to prevent injury and correct my strengths and limitations based upon the profile created from the screen. My participation in this study will also help allied health care practitioners understand a Division II University dancer; and may provide valuable information on reducing injuries and enhancing performance.

8. I understand that the results of the research study may be published but my name or identity will not be revealed. Only aggregate data will be reported. In order to maintain confidentially of my records, Jena Hansen-Honeycutt will maintain all documents in a secure location on campus and password protect all electronic files so that only the student researcher and research advisor can access the data. Each subject will be given a specific subject number to represent his or her name so as to protect the anonymity of each subject.

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

10. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:

Jena Hansen-Honeycutt, LAT, ATC
STUDENT/PRIMARY RESEARCHER
Han8049@calu.edu
360-303-6430

Rebecca Hess, PhD
RESEARCH ADVISOR
Hess_ra@calu.edu
724-938-4356

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

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

13. This study has been approved (#12-025) by the California University of Pennsylvania Institutional Review Board.

14. The IRB approval dates for this project are from: 3/5/2013 to 3/4/2014.

Subject's signature:_____
Date:_____

Witness signature:_____
Date:_____

APPENDIX C2

Subject Information

Subject #:_____

Age:_____

Dance Class Enrolled in at University:_____

Dance Experience:

Type:_____ Setting:_____ Yrs:_____

Type:_____ Setting:_____ Yrs:_____

Type:_____ Setting:_____ Yrs:_____

Previous Injuries:

Non- Dance related injuries:

Injury:_____

Cause of injury: Trauma/Overuse

Treatment:_____ Year:_____

Dance related injury:

Injury:_____

Cause of Injury: Trauma/Overuse

Treatment:_____ Year:_____

Did it occur while dancing or because of dance?_____

Were you still able to dance?_____

Dance related injury:

Injury:_____

Cause of Injury: Trauma/Overuse

Treatment:_____ Year:_____

Did it occur while dancing or because of dance?_____

Were you still able to dance?_____

APPENDIX C3

Preventative Screening Form 2004

HARKNESS CENTER for Dance Injuries

HARKNESS CENTER FOR DANCE INJURIES: PREVENTATIVE SCREENING FORM

(Marijeanne Liederbach©1989 v04)

NAME OF DANCER: _____ **TODAY'S DATE:** _____

Gross posture & motion:

A/P

Active 4 shld-scap motion tests _____N _____Ab (side if Ab: _____)
Iliac crest height symmetry _____Y _____N
Scoliometer : 45°(T6)_____R/L 60°(T12-L1)_____R/L 90°(L3-4)_____R/L
Foot: **Calcaneal eversion (≥4°)** _____R _____L (Yes / No)
"Number of Toes" Sign _____R _____L
Pes line _____R_____L ↑ / ↓
Foot type _____R_____L Cavus (C) / Planus (P)
Forward bend test _____R (+ / -) _____L (+ / -)
Backward bend test _____R (+ / -) _____L (+ / -)
March test _____R (+ / -) _____L (+ / -)

Sagittal

Forward head _____Y _____N
Fwd shoulders/kyphotic _____Y _____N
Flat back or sway back _____Y _____N (specify: _____)
Genu recurvatum _____R (≥ 15° / <15°) _____L (≥ 15° / <15°)

Flexibility / ROM:

Standing / Floor Sitting:

Can pt. dome foot? _____R(yes/no) _____L(yes/no)
Mod. Beighton: ·Thumb-to-thumb _____tight _____loose ·Toe touch _____tight _____loose
·Lotus _____tight _____loose ·HAD straddle _____ (> 90° / ≤ 90°)

Supine / Long Sitting:

	R	L
Dancer's Thomas: Psoas	_____tight/loose	_____tight/loose
Rectus	_____tight/loose	_____tight/loose
ITB	_____tight/loose	_____tight/loose
Sartorius	_____tight/loose	_____tight/loose
Hamstring:	_____ (<120°/≥120°)	_____ (<120°/≥120°)
Active open chain dorsiflexion	_____(≤5° / >5°)	_____(≤5° / >5°)
Active plantar flexion symmetry	_____Y	_____N
Passive subtalar joint eversion	_____(≤5° / >5°)	_____(≤5° / >5°)
Passive great toe dorsiflexion	_____(<90° / ≥90°)	_____(<90° / ≥90°)
Thomasson sign?	_____(yes / no)	_____(yes / no)
Hip: Prone HER	_____ (>45° / <45°)	_____ (>45° / <45°)
Prone HIR	_____ (>45° / <45°)	_____ (>45° / <45°)

MMT Strength:

Terminal Hamstring R_____L_____
R_____L_____
x _____x_____ %Deficit _____

Hip Abduction R_____L_____
R_____L_____
x _____x_____ % Deficit _____

Normative Data	
M	F
22.3 ± 1.7	15.1 ± 0.5

Hip Adduction R_____L_____
R_____L_____
x _____x_____ % Deficit _____

Normative Data	
M	F
23.7 ± 0.9	15.2 ± 0.4

Hip Flexion R_____L_____
R_____L_____
x _____x_____ % Deficit _____

Normative Data	
M	F
32.0 ± 3.1	22.3 ± 2.1

HARKNESS CENTER for Dance Injuries

Shoulder Abduction	R_____L_____	Normative Data	
	R_____L_____	M	F
	x _____x _____ % Deficit _____	12.1 ± 0.7	6.2 ± 0.3

Functional Strength & Skill Tests:

- **Kendall supine double straight leg lower** _____ (Pass [5/5] _____Fail [≤4/5])
- **Standing turnout** _____ ° Total
  Disc turnout _____ ° Total
  Force differential _____ #
- **First Position Relevé(*note pelvis*- APT/Neutral/PPT):** _____R_____L
  Normal (calcaneal midline & mid patella aligned with 2nd ray)
  Med (calcaneal midline & mid patella medial to 2nd ray)
  Lat (calcaneal midline & mid patella lateral to 2nd ray)
- **Calcaneal height symmetry test (L & R same height?)** _____Y _____N
- **Functional DF ROM - first position parallel plié** _____R _____L
  Pass (plumb line from patella to toe tips or distal)
  Fail (plumb line from patella to met heads or proximal)
- **Second Position Progression Angle of Knee (*note pelvis* – APT/Neutral/PPT):** _____R_____L
  Normal (knee over second ray)
  Min (knee over first ray)
  Mod (knee just medial to first ray)
  Max (knee grossly medial to first ray)
- **Rhomberg (pass/fail)** _____R_____L
- **Single leg strategy (hip/ankle)** _____R_____L
- **25 Heel Raises in neutral parallel 1st** _____R_____L
  Pass: maintains full heel height over consecutive 1-second repetitions without knee flexion moment
  Fail: unable to maintain above criteria
- **5 Single Leg Bench Step Down (eyes open & closed)** _____R_____L (EO)
  Pass: maintains patellar center over 2nd ray _____R _____L (EC)
  Fail: demonstrates valgus - patellar center medial to 1st ray or LOB)
- **"Airplane" Pliés with Trunk Rotation & Proprio Overload** _____R _____L
  Pass: 5 demi pliés on pillow, pitched fwd // arabesque, maintaining LE alignment & balance during B 90° trunk and gaze rotation
  Fail: loses control of above criteria
- **5 Pushups with trunk control (plank and inverted (handstand)** _____P ____F (plank)
  _____P ____F (inverted)
- **5 Plank → side plank (one arm, one foot balance) pose** _____R _____L
  Pass: able to do consecutive B plank to side plank rotations with slow, steady control
  Fail: fatigues, loses trunk control or balance
- **Jumping**
  Parallel Single Leg "Sauté" or "High Jump" (height) _____R (in.) _____L (in.) _____ΔR/L
  Parallel Single Leg "Jeté" or "Long Jump" (distance) _____R (in.) _____L (in.) _____ΔR/L
- **Harvard bench step test** _____P_____F
  (bpm: _____) (bpm @ 1 min post: ____)

Special Orthopedic Tests:

APPENDIX C4

Functional Screen 1997

Table 3 Functional Dance Screening — Harkness Center for Dance Injuries

Station 1 — Postural Symmetry

AP Scan (↑/↓)

Acromion	R _____	L _____
Inferior Scapular Angle	R _____	L _____
Iliac Crests	R _____	L _____
PSIS	R _____	L _____
ASIS	R _____	L _____
Greater Trochanter	R _____	L _____
Fibular Head	R _____	L _____
Medial Malleolus	R _____	L _____

"True" LL Equality Test

ASIS to Medial Malleolus R _____ cm L _____ cm

Scoliometer®

Adams forward bend:

45° forward flexion (T6): _____° (Convexity R/L)
60° forward flexion (T12-L1): _____° (Convexity R/L)
90° forward flexion (L3-4): _____° (Convexity R/L)
Other: _____° (Convexity R/L where?) _____° (Convexity R/L where?)

Station 2 — Fitness

Body Composition

Skyndex®	_____% fat
Waist	_____ in
Hip	_____ in
Waist/Hip Ratio	_____

Three-Minute Harvard Step Test (18" at 24 steps per minute)

Immediate three minute post h.r.	_____ bpm's
One minute post	_____ bpm's

Three-Minute Jump-rope Test

Immediate three minute post h.r.	_____ bpm's
One minute post	_____ bpm's

Station 3 — Strength

Muscle Tests

Hip Flexion	1. R _____	L _____		
	2. R _____	L _____		
	x _____	x _____	% Def _____	
Hip Abduction	1. R _____	L _____		
	2. R _____	L _____		
	x _____	x _____	% Def _____	
Hip Adduction	1. R _____	L _____		
	2. R _____	L _____		
	x _____	x _____	% Def _____	
Terminal Knee Flexion	1. R _____	L _____		
	2. R _____	L _____		
	x _____	x _____	% Def _____	

Station 4 — Functional Capacity

Plié	R _____ sec	L _____ sec
Leg Power (horizontal jeté)	R _____ cm	L _____ cm
Leg Power (vertical sauté)	R _____ cm	L _____ cm
Rhomberg (parallel first with contralateral coup de pied)	R _____ sec	L _____ sec
Single Turn Topple (Y/N)	R _____	L _____

Station 5 — Hip Range of Motion

Ryder (A = Ante / N = Normal / R = Retro)		R _____	L _____
Sitting Tibial Torsion (IR / N / ER)		R _____	L _____
Prone HER (°)		R _____	L _____
Prone HIR (°)		R _____	L _____
Standing Turnout (°)	B _____ or	R _____	L _____
Disc Turnout (°)	B _____ or	R _____	L _____
Game scale force (HIR torque - #'s)		R _____	L _____

continued . . .

Station 6 — Flexibility

Toe Touch R _____ L _____
(S = short of floor touch, F = fingers to floor, P = palms to floor, H = heels of hands beyond heels of feet)
Standing Flexion S-I Function (S / +R / +L)
UE Rotation/Extension (+ / -) R _____ L _____
(+ = tight, - = loose)
Overhead UE Function (N / B / +R / +L)
Recurvatum (+ = ≥ 10°) R _____ L _____
Lotus (+ / -) R _____ L _____
(+ = tight, unable to sustain on floor; - = loose)
Sitting Flexion (S / +R / +L)
Dancers Supine Thomas Test R _____ L _____
(+ = tight, unable to reach table surface with 90° KF; ++ = above plus hip abd and ltd KF; - = loose)
Sitting Second Position _____ °
Ober (+ / -)

Station 7 — Foot Biomechanics

Ankle Dorsiflexion
Sitting Norkin (30° KF) R _____ L _____
Prone Hagins (90° KF with over pressure) R _____ L _____
Standing Hagins (first plié) R _____ L _____
Ankle Plantar Flexion
Sitting Norkin R _____ L _____
Sitting Novella R tib _____ L tib _____
R talus _____ L talus _____
R Δ _____ L Δ _____
Pes Line (↑ / ↓) R _____ L _____
Forefoot Abductus (number of toes) R _____ L _____
Calcaneal Eversion (+ = 4°) R _____ L _____
Great Toe Standing Extension (°) R _____ L _____
Great Toe Passive Extension (°) R _____ L _____
Thomasson Sign (+ = trigger) R _____ L _____
First Ray (PF-M / PF-I / DF-M / DF-I) R _____ L _____

Station 8 — Orthopaedic Evaluation

General Posture:
Cervical Spine:
UE's:
Back:
Hips:
Clicking + - If yes, location? _____ If yes, pain? _____
Snapping + - If yes, location? _____ If yes, pain? _____
LBP + -
Knees:
Parallel squat test for pain: + -
Second position progression angle: Normal (knee over second ray)
Min (knee over first ray)
Mod (knee just medial to first ray
Severe (knee grossly medial to first ray)
Lachman: + -
Valgus: + -
Varus: + -
Q angle: (N / ↑)
Ankles/Feet:
Cavus / Planus
Misc:

APPENDIX C5

Institutional Review Board –

California University of Pennsylvania

Institutional Review Board
California University of Pennsylvania
Morgan Hall, Room 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP,Chair

Dear Ms. Hansen-Honeycutt:

Please consider this email as official notification that your proposal titled "Preventative Functional Screening in University Dancers: Considerations for an Evidence-Based Training Program" (Proposal #12-025) has been approved by the California University of Pennsylvania Institutional Review Board as amended.

The effective date of the approval is 3-5-2013 and the expiration date is 3-4-2014. These dates must appear on the consent form .
Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 3-4-2014 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.
Regards,
Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

APPENDIX C6

Preventative Screening Form

Excel spreadsheet of Raw Data

Special/Functional Tests	Part. 1	Part. 2	Part. 3	Part. 4	Part. 5	Part. 6	Part. 7	Part. 8	Part. 9	Part. 10	Part. 11	Part. 12	Part. 13
Time	55	52	53	45	38	40	45	39	35	32	35	36	35
Scapular Motion Abd	N	N	N	N	Y R	N	N	N	N	N	N	N	N
Iliac Crest Sym	Y	N	Y	Y	Y	Y	Y	N	Y	N	N	Y	N
Scoliometer	0	3R/0/0	10R/0/0	0	0	0	0	0	0	0/0/4R	0	0	0
Calcaneal EversionR≥4	Y	N	N	N	N	N	N	Y	Y	Y	Y	N	N
Calcaneal EversionL≥4	N	Y	Y	Y	N	N	N	Y	N	Y	Y	N	Y
"Number of Toes" R	2	1	2	3	2	1	3	3	3	2	3	2	2
"Number of Toes" L	2	3	2	3	1	1	2	2	2	2	2	1	2
Pes Line R	↓	=	=	↓	=	↓	↓	↓	↓	=	↓	↓	↑
Pes Line L	↓	↓	=	↓	↑	↓	↓	↓	↓	↓	↓	↓	↑
Foot type (Cavus/Planus) R	C	P	P	P	P	P	P	C	P	P	P	C	C
Foot type (Cavus/Planus) L	C	P	P	P	P	P	P	C	P	P	P	C	C
Forward bend test R	-	-	-	-	-	-	-	-	-	-	-	-	-
Forward bend test L	-	-	+	-	-	-	-	-	-	-	-	-	-
Backward bend test R	-	-	-	-	-	-	-	-	-	-	-	-	-
Backward bend test L	-	-	-	-	-	-	-	-	-	-	-	-	-
March test R	+	+	-	-	-	-	-	-	+	-	-	-	-
March test L	-	-	+	-	-	-	-	+	-	+	-	+	-
Forward head	N	N	N	N	N	N	N	N	N	N	N	N	N
Forward shoulder	N	N	N	N	N	N	N	N	N	N	N	N	N
Flat back/Sway back	Y	N	N	Y Sway	N	Y Flat	N	N	N	N	N	N	Y Sway
Genu recurvatum R	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Genu recurvatum L	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Dome foot R	Y	N	N	N	Y	N	N	Y	N	N	N	Y	Y
Dome foot L	N	N	N	N	Y	Y	Y	Y	N	Y	N	Y	N
Thumb to thumb	Loose	Tight	Loose	Loose	Tight	Loose	Loose	Tight	Loose	Tight	Loose	Tight	Tight
Lotus	Tight	Loose	Loose	Loose	Tight	Tight	Tight	Tight	Tight	Tight	Loose	Tight	Tight
Toe Touch	Loose	Loose	Loose	Loose	Tight	Loose	Loose	Loose	Loose	Tight	Loose	Tight	Loose
HAD Straddle	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
Psoas R	Loose	Loose	Loose	Loose	TIght	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Tight
Psoas L	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose
Rectus R	Loose	Loose	Loose	Loose	Tight	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose
Rectus L	Loose	Loose	Loose	Loose	Tight	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose
ITB R	Tight	Loose	Tight	Loose	Loose	Loose	Loose	Tight	Tight	TIght	Tight	Tight	Loose
ITB L	Tight	Loose	Tight	Loose	Tight	TIght	Tight	Tight	Tight	Tight	Tight	Tight	Loose

Sartorius R	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Tight	Loose	Loose	Loose	Loose	Loose
Sartorius L	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Loose	Tight	Tight	Tight	Loose
Hamstring R	<120	<120	>120	>120	<120	<120	>120	<120	<120	<120	>120	<120	>120
Hamstring L	<120	<120	<120	<120	<120	<120	>120	<120	>120	<120	>120	<120	>120
A dorsiflexion R	>5	<5	>5	>5	>5	<5	<5	<5	>5	<5	>5	>5	<5
A dorsiflexion L	>5	>5	>5	>5	>5	<5	<5	<5	>5	<5	>5	>5	<5
A plantar flexion Sym	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
P subtalar joint eversion R	>5	>5	>5	>5	>5	>5	>5	>5	<5	>5	>5	>5	<5
P subtalar joint eversion L	>5	<5	>5	<5	<5	>5	>5	>5	>5	>5	>5	>5	>5
P great toe dorsiflexion R	<90	<90	>90	>90	<90	>90	>90	<90	>90	<90	>90	<90	<90
P great toe dorsiflexion L	<90	<90	>90	>90	<90	>90	>90	>90	>90	<90	>90	<90	<90
Thomasson sign (tight) R	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Thomasson sign (tight) L	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
HER R	<45	<45	>45	<45	<45	>45	<45	<45	<45	<45	<45	<45	<45
HER L	<45	>45	>45	<45	<45	<45	<45	<45	<45	<45	<45	<45	<45
HIR R	>45	>45	<45	>45	<45	<45	>45	<45	>45	<45	>45	<45	<45
HIR L	>45	<45	<45	>45	<45	>45	<45	>45	>45	<45	>45	<45	<45
Hamstring Avg R	24.3	9.2	13.3	15.8	13.8	10.7	11.9	14.0	9.8	9.1	15.3	11.7	11.6
Hamstring Avg L	11.2	10.7	26.4	18.6	13.3	10.5	12.7	12.9	9.2	8.9	14.9	15.0	11.0
Hamstring strength %	46%	86%	50%	85%	96%	98%	93%	92%	94%	98%	97%	78%	94%
Hip ABD Avg R	10.5	10.4	10.0	14.2	12.4	10.3	12.0	10.4	9.2	8.6	10.8	9.8	9.8
Hip ABD Avg L	11.5	10.5	9.7	15.4	10.3	9.1	12.7	10.1	8.7	9.0	12.3	10.5	8.2
Hip ABD strength % B	91%	99%	97%	92%	83%	88%	94%	97%	95%	96%	88%	93%	84%
Hip ADD Avg R	9.7	10.5	10.2	13.7	14.9	11.0	10.6	7.0	7.8	9.3	9.9	9.4	8.2
Hip ADD Avg L	11.4	11.5	8.4	13.1	11.0	8.9	9.4	9.0	7.1	9.5	9.2	10.8	8.0
Hip ADD strength % B	85%	91%	82%	96%	94%	81%	89%	77%	91%	98%	93%	87%	98%
Hip Flexion Avg R	15.9	13.4	14.7	1.7	15.8	13.3	11.6	9.6	9.1	13.3	14.5	12.8	12.3
Hip Flexion Avg L	15.3	12.5	15.2	16.8	14.1	13.4	15.8	9.8	9.6	13.2	12.6	13.7	12.8
Hip Flexion strength%	96%	93%	97%	99%	89%	99%	73%	98%	95%	99%	87%	93%	96%
Shoulder ABD Avg R	7.7	7.1	6.3	8.2	6.0	5.0	4.7	6.4	5.2	5.9	6.7	7.2	6.3
Shoulder ABD Avg L	7.8	5.8	7.2	9.0	5.2	6.0	4.5	5.3	4.7	6.0	6.3	6.9	5.8
Shoulder Abd strength %	99%	82%	88%	91%	87%	83%	95%	83%	90%	98%	94%	96%	92%
Kendall	P	P	P	P	P	P	P	P	P	P	P	P	P
Standing turnout°	106	110	94	85	96	118	104	104	78	91	101	90	110
disc turnout°	112	132	112	110	102	114	114	116	105	104	112	99	125
force differential°	6	22	18	25	6	4	10	12	27	13	11	9	15

First position relevé R	Nor	Med	Nor	Med	Nor	Med	Med	Med	Med	Nor	Nor	Nor	Nor
First position relevé L	Lat	Nor	Med	Med	Med	Med	Nor	Med	Med	Nor	Nor	Nor	Nor
calcaneal height symmetry	N	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N
first position parallel plié	P	P	P	P	P	P	P	P	P	P	P	P	P
second position R	Mod	Mod	Mod	Max	Max	Max	Max	Max	Max	Max	Max	Max	Min
second position L	Mod	Mod	Mod	Max	Max	Max	Mod	Max	Mod	Max	Max	Mod	Mod
rhomberg R	P	P	P	P	P	P	P	P	P	P	P	P	P
rhomberg L	P	P	P	P	P	P	P	P	P	P	P	P	P
single leg strategy R	A/H	A/H	A/H	A	A	A	A/H	A	A	A/H	A/H	A/H	A
single leg strategy L	A	A	A	A	A	A	A/H	A	A	A/H	A	A/H	A/H
heel raises R	P	P	P	P	P	P	P	P	P	P	P	P	P
heel raises L	P	P	P	P	P	F	P	P	P	P	P	P	P
step down EO R	P	P	P	P	P	F	P	P	F	F	P	P	P
step down EO L	P	P	P	P	P	F	P	P	P	F	F	P	p
step down EC R	P	F	P	P	P	F	F	F	F	F	F	F	P
step down EC L	F	F	P	F	F	F	P	F	F	F	P	P	F
Airplane R	P	P	P	F	P	P	F	F	P	P	F	P	F
Airplane L	P	P	P	F	F	P	P	P	F	F	P	P	F
5 Pushups	P	F	P	P	F	F	P	P	P	F	F	P	F
plank --> side plank R	F	F	F	F	F	F	F	F	F	F	F	F	F
plank --> side plank L	F	F	F	F	F	F	F	F	F	F	F	F	F
single leg sauté ΔR/L	1	1	1	1	1	1	2	2	2	1	1	1	1
single leg jeté ΔR/L	1	3	4	1	1	4	2	2	4	1	1	2	0
Harvard bench step	P	P	P	P	P	P	P	P	P	P	P	P	P

APPENDIX C7

Corrective Exercise Pictures

Corrective Exercise Pictures

1)

2)

3)

4)

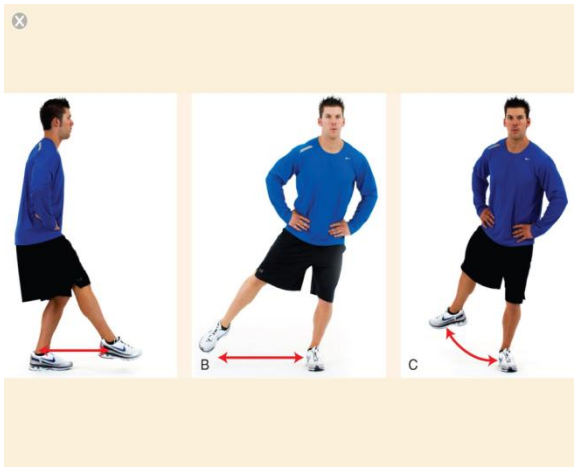
5)

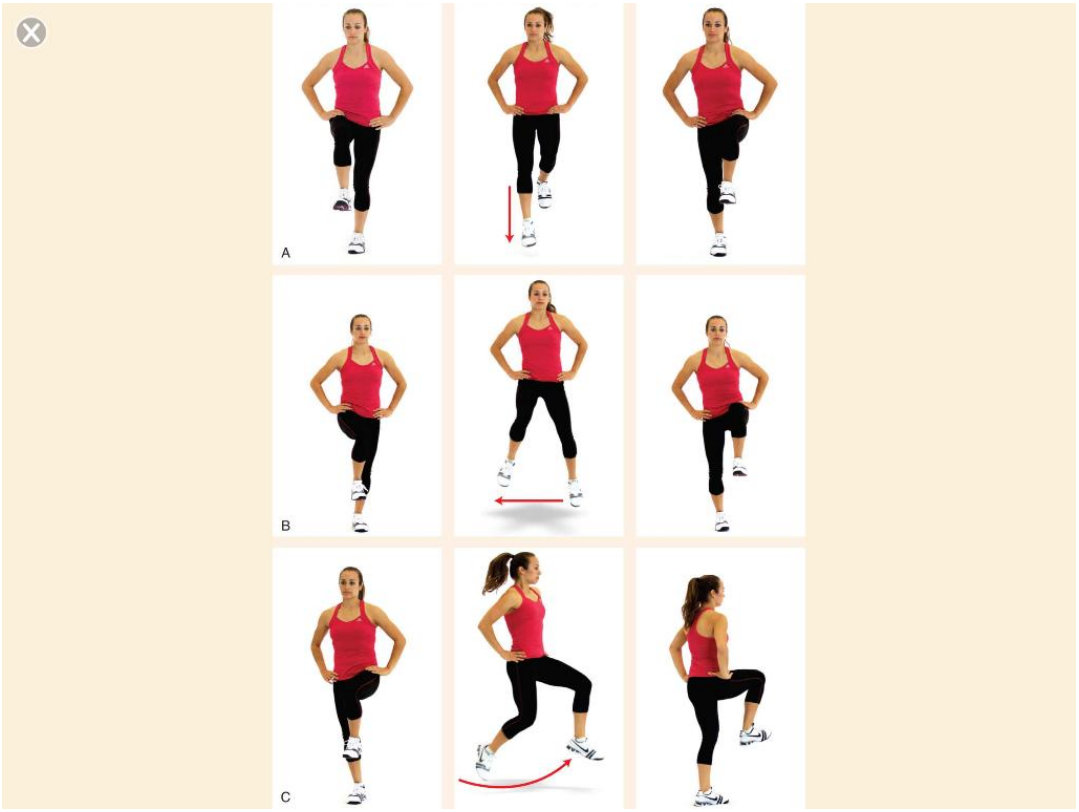
6)

1)Plank 2)Plank with leg Abduction 3)Swiss Ball Crunch 4)Hamstring PNF/ External rotators PNF 5)Single Leg Balance Progressions 6)Single Leg Balance Progressions

Corrective Exercise Pictures

7) 

8) 

8) 

7)Self-myofascial release ITB 8)Single Leg Balance Reach Progressions 9)Single leg hop progressions

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ABSTRACT

TITLE: Preventative Functional Screening In University Dancers: Considerations For an Evidence-Based Training Program

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DATE: May 2013

PURPOSE: The purpose of this research was to use a functional screen to create a profile of a Division II university dancer.

METHODS: This study used a qualitative research design in which an evidence-based training program was developed. Data was collected on university dancers by using a functional screen. Results of the dance screen were organized into an Excel spreadsheet and used to systemically identify errors to create a profile.

FINDINGS: The functional screen did provide information to develop a profile of strengths and limitations of a Division II dancer. The profile allowed the researcher to identify global errors that should be addressed with a corrective exercise program. The functional screen also assisted in identifying underlying dysfunctions that need to be addressed prior to starting a corrective training program.

CONCLUSIONS: The functional screen was an effective tool in creating a profile of a Division II dancer. By using the profile, the researcher was able to identify global errors where dancers could use corrective training to decrease risk of injury and improve functional movement patterns.