NYU

Welcome to Physical Therapy for Performing Artists

Dr. Emily Sandow, DPT, OCS

CCL IGNITE 2025

Overview

01.

My story

02.

My work

03.

Activity

NYU

Warm up activity

- Introduce yourself
- Which Borough are you from
- HOW MANY trains and buses did you ride today to get here?
- What is a hidden talent?

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My story

- Earliest science or career exposure story!
- Where did I go to school?
- What do my credentials stand for?
- What are my current roles
- What’s the best part of my job?

About Me

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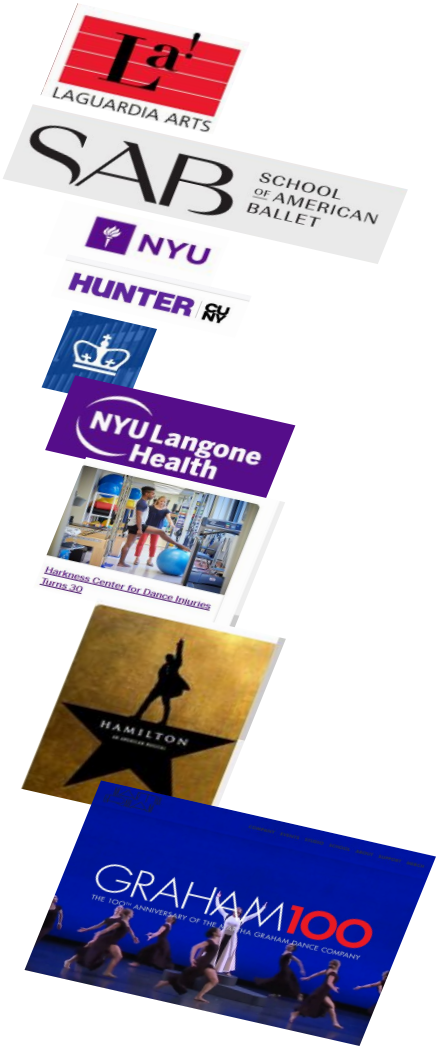
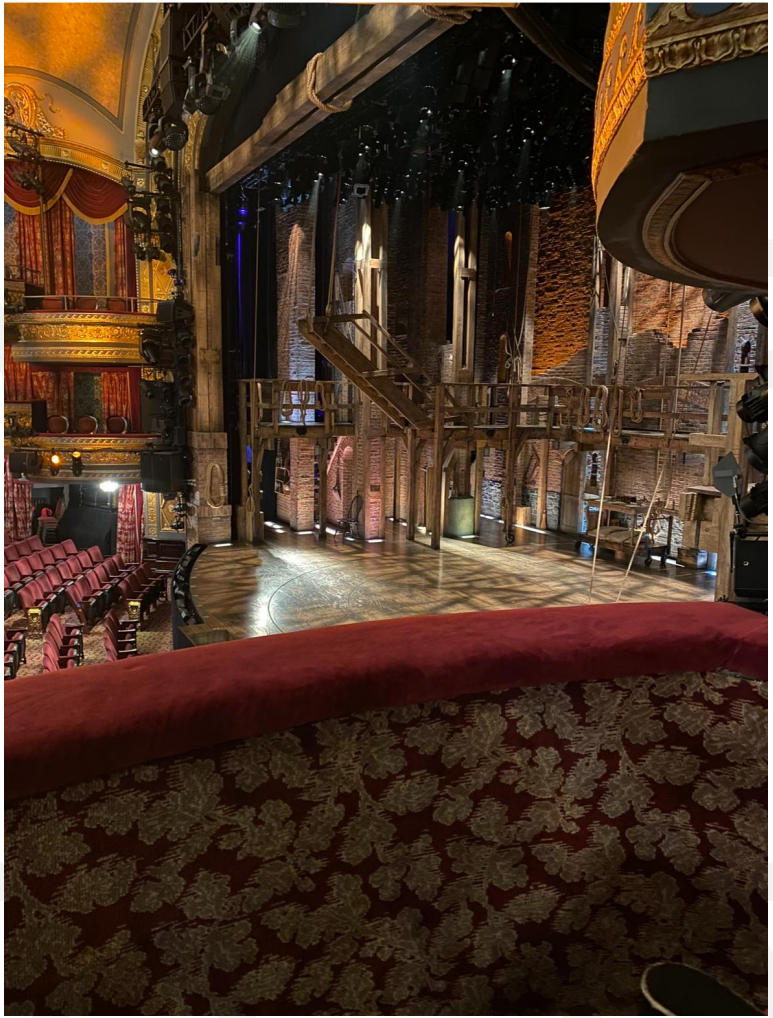

LAGUARDIA ARTS
SAB
SCHOOL OF AMERICAN BALLET
NYU
HUNTER
NYU Langone Health
Harkness Center for Dance Injuries Turns 30
HAMILTON
GRAHAM 100

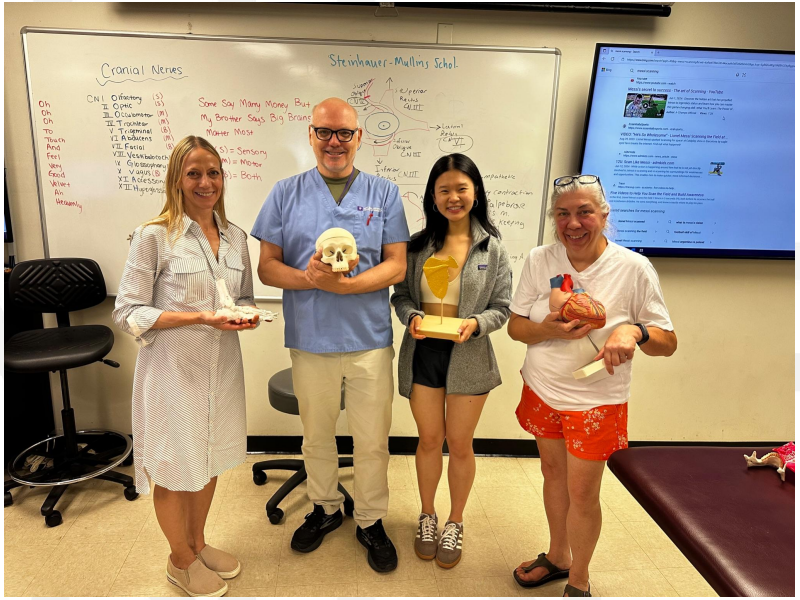
A week in my life

- What an average Week looks like



My office

“The room where it happened”


Cranial Nerves
Stemhauer-Mullins School
Some Say Marry Money But
My Brother Says Big Brains
Matter Most

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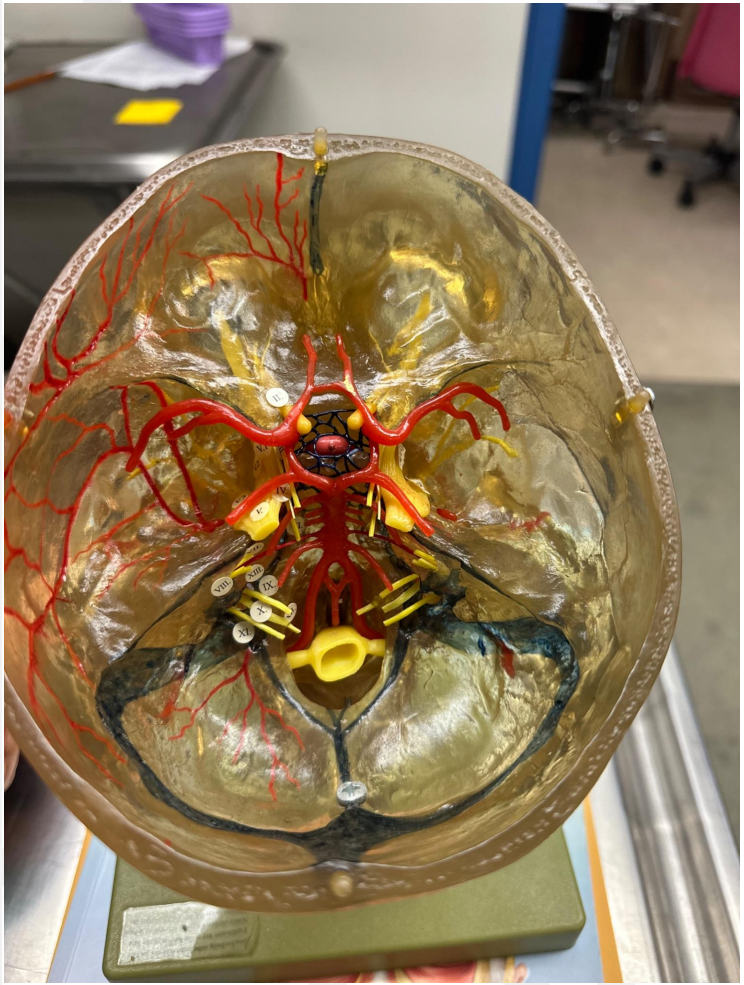

Anatomy Lab

Circle of Willis

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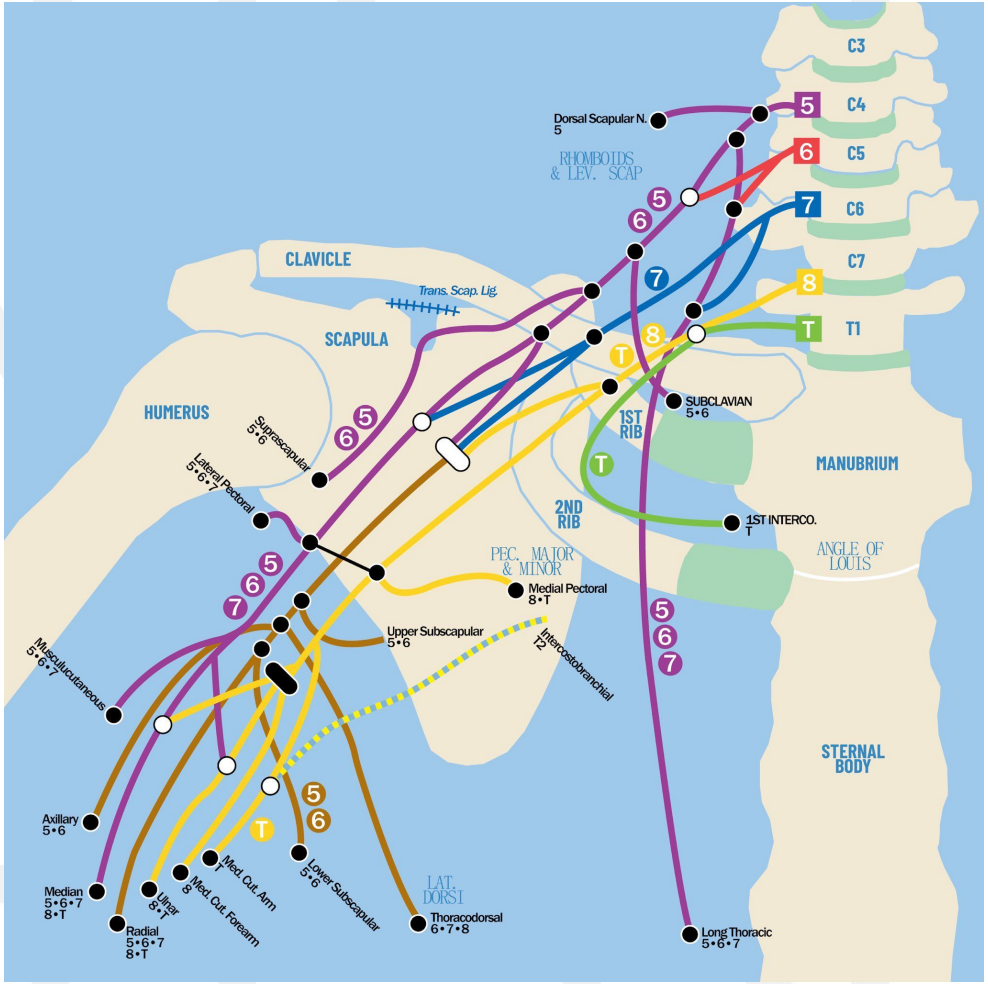
fitness focus
ANKLE WORKOUT I
You will need
A RAISED SURFACE SUCH AS A STEP
ANKLE WORKOUT II
You will need
A THERABAND
WANT MORE?
DOs & DON'Ts
DO
DON'T
DON'T
November 2003 • www.dance-teacher.com


fitness focus
Focus On...développé devant and à la seconde
up, up and away!
by Jeni Tu
How to help students achieve lovely développé devant and à la seconde—without strain and overcompensation
HAMSTRING STRETCH
DOs & DON'Ts
DO
DON'T
ARABESQUES
Core 2 riculum
THE DEAD BUG
Consultant Shaw Bronner
www.dance-teacher.com • April 2003


fitness focus
Focus On... Stretches
that's stretch
Work on your flexibility with these 8 handy after-class stretches
PIRIFORMIS & EXTERNAL ROTATORS
HIP STRETCH
HIP & QUAD STRETCH
HAMSTRING STRETCH
ILIO-TIBIAL BAND STRETCHES
SPINE STRETCH
FOOT fetish
Bonus!
Note:
October 2003 • www.dance-teacher.com



Map of the nervous system

What I would tell my younger / 16 year old self

- Its ok to accumulate many interests :)

PART 02

My work

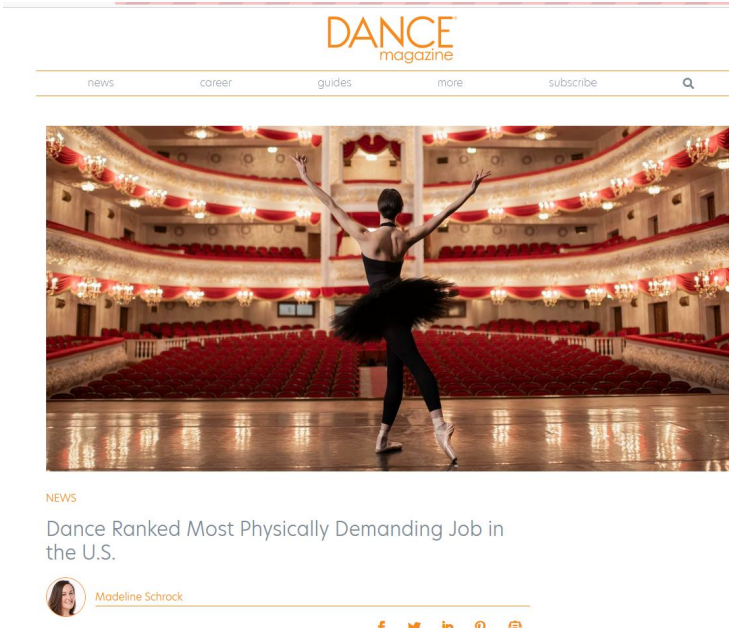
Please share a recent project or publication

What do you think is the most demanding Job in the US?

- Firefighters
- Brick masons
- Roofers
- Dancers
- Athletes
- Tree Trimmers

Dance Ranked Most Physically Demanding Jobs in the US

- Analyzed data from US Department of Labor
- Analyzed level of
  - Strength
  - Stamina
  - Flexibility
  - Coordination
- Joining dance in the top 20 were:
  - Iron and steel workers
  - Roofers
  - Firefighters
  - Construction workers
- Dancers scored an average of 97/100 for level of job physicality
  - Dancers scored 100 out of 100 in the stamina, flexibility and coordination categories,
  - Dancers scored 87.8 out of 100 for strength



Occupation	Rank	Overall physical demand index	Strength index	Stamina index	Flexibility index	Coordination index	Total employment	Mean annual wage
Dancers	1	97.0	87.8	100.0	100.0	100.0	9,720	43056
Derrick Operators, Oil and Gas	2	92.0	93.4	88.7	93.4	92.5	11,310	47630
Athletes and Sports Competitors	3	90.4	95.3	98.1	71.9	96.2	10,800	87030
Manufactured Building and Mobile Home Installers	4	90.3	93.4	88.7	85.9	93.4	2,920	32910
Fitness Trainers and Aerobics Instructors	5	88.5	77.5	98.1	80.3	98.1	308,470	44580
Structural Iron and Steel Workers	6	88.4	97.1	76.6	85.9	94.3	77,410	58170
Roofers	7	86.9	88.7	88.7	73.8	96.2	128,680	43870
Fallers	8	85.2	91.5	93.4	65.4	90.6	4,680	48520
Choreographers	9	83.1	57.9	97.1	78.5	99.0	5,090	53560
Reinforcing Iron and Rebar Workers	10	80.1	81.3	88.7	72.8	77.5	18,360	$54,670
Drywall and Ceiling Tile Installers	11	79.4	64.4	76.6	85.9	90.6	101,900	$49,170
Roof Bolters, Mining	12	79.3	88.7	76.6	74.7	77.5	3,250	$59,090
Tree Trimmers and Pruners	13	78.5	85.0	76.6	74.7	77.5	42,440	$40,510
Commercial Divers	14	77.3	53.2	76.6	92.5	86.9	3,380	$59,470
Helpers--Roofers	15	64.9	98.1	N/A	67.2	94.3	8,630	$31,740
Firefighters	16	64.0	72.8	96.2	N/A	86.9	321,570	$53,240
Construction Laborers	17	60.5	98.1	88.7	55.1	N/A	1,001,470	$40,350
Stonemasons	18	60.0	100.0	76.6	N/A	63.5	12,310	$44,370
Laborers and Freight, Stock, and Material Movers, Hand	19	58.4	96.2	76.6	60.7	N/A	2,893,180	$30,890
Brickmasons and Blockmasons	20	57.7	88.7	N/A	76.6	65.4	63,930	$54,430

Courtesy InsuranceProviders.com

Who are dancers?

- Athletes?
- Artists?

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Are dancers athletes or artists?

- Dance is a balance between artistry and athleticism
- **“Train like an athlete, perform like an artist”**
- Dance practiced as both a vocation and recreational activity
  - With unique demands of being both
    - an aesthetic art form
    - and a physically demanding sport
    - With a high incidence of injury

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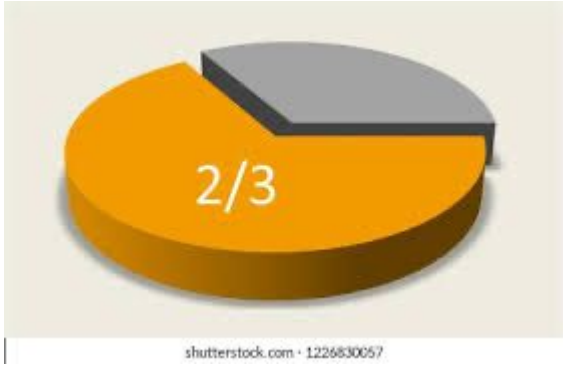
Which is more mentally and physically demanding: ballet or football?

- The first study of its kind, published in the Journal of Sports Medicine in 1975, ranked the demands of ballet ahead of 60 other physical activities, including football.
- Ballet, according to a 1975 study by Dr. James A. Nicholas in The Journal of Sports Medicine. The study, which ities, lly and ved by all.

PART 02

The Problem:
why so many injuries in dancers?

- Lifetime injury rate in dancers as high as 84%
- 65% of **dance** injuries are a result of **chronic overuse**
- 35% of dance injuries result from **trauma**
- 90% of injuries are the result of fatigue
- Alternatively, in college **basketball**:
  - 2:1 trauma: overuse



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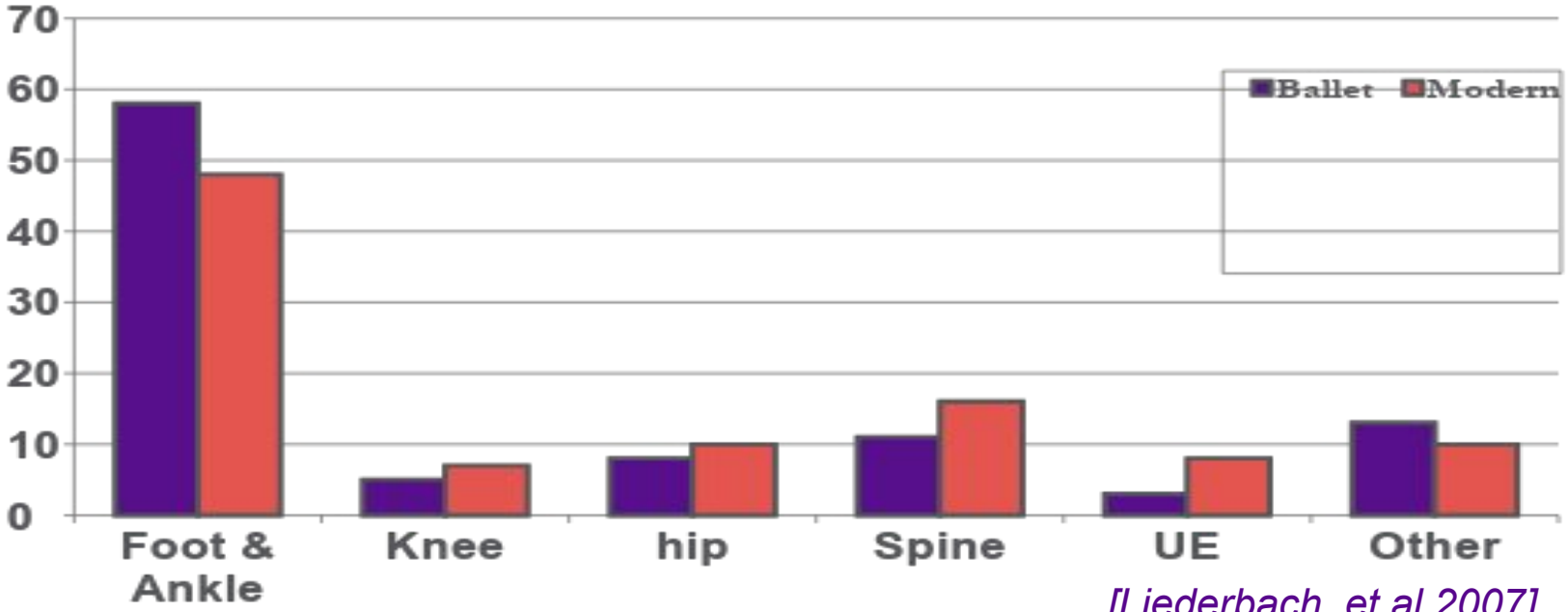
Where:
% Distribution of Injuries by Site



[Liederbach, et al 2007]

Why foot and ankle?

Fig. 2. Sagittal plane 3.0 T PDW image of a dancer in the *en pointe* scanning position. White arrowheads identify the pos terior edge of the tibia, posterior talus, and superior calcaneus that converge in the *en pointe* position. The white rectangular bracket denotes the portion of the posterior tibial articular surface that rests on the posterior talus rather than on the articular dome of the talus.

PART 02

The solution?
How can we prevent injuries in dancers?

- Identify risk factors in dancers
  - See if any are modifiable
- Intrinsic risk factors
- Extrinsic risk factors

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Performing Arts Medicine

- Training
- Types of settings
- Types of injuries
- Education and Prevention
- Clinical Treatment
- Research

Dance Medicine

- Three things distinguish dance from sports:

1. Goals and rewards

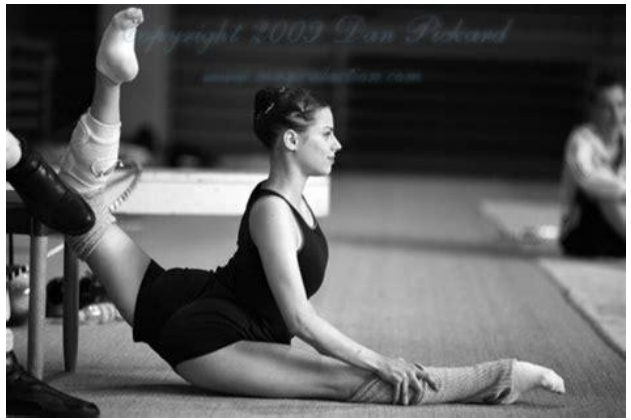
  - Not motivated by trophies, medals
  - Not motivated by strength, speed, time

2. Movement demands:

  - Extreme ROM in lower extremities, hips ankles, back

3. It's training traditions

  - Artistic not scientific
  -



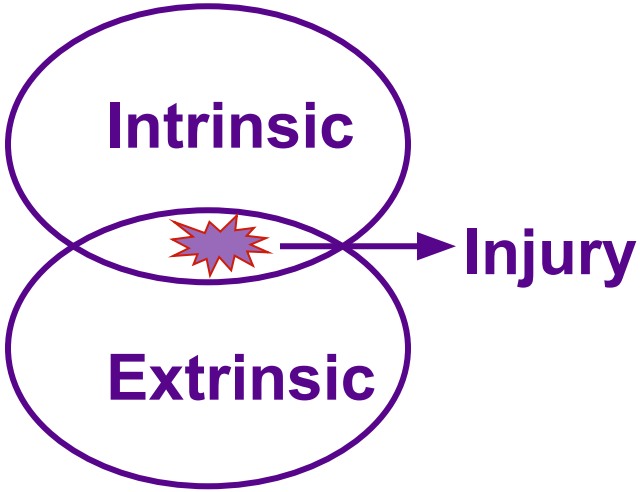
- The unique mechanisms of injury and impairments in dancers requires a specialized approach to prevention of injury and treatment of this dance population.

How do these injuries happen?

Injuries result from a complex interplay between

intrinsic and extrinsic variables

- **FATIGUE**



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[Backx, Bol, Junge, Meeuwisse, MacMahon & Pugh, Murphy, van Mechelen]

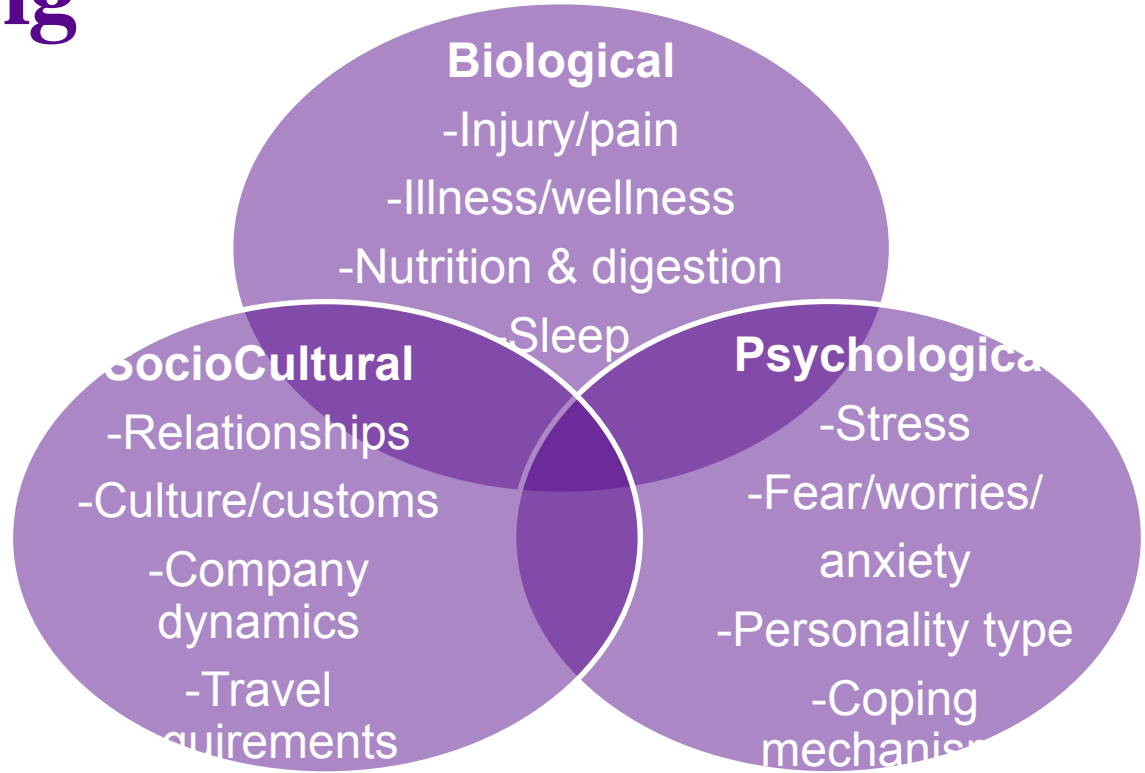
Extrinsic Factors Associated with Dance Injury

- shoes,
- floor,
- set design,
- lighting,
- temperature,
- technique type,
- music tempo
- Time of day
- Environmental
- Overtraining, specificity of training
- Teacher, peer pressure
- School and home stressors

Intrinsic Factors Associated with Dance Injury

- Gender, sex, age, weight, height,
- Personality type,
- Prior injury history,
- Anatomical constraints
- Faulty movement and posture
- Flexibility and hypermobility,
- Ability to jump, point foot, turnout, developpé, etc.
- E pluribus unum: Variety of norms

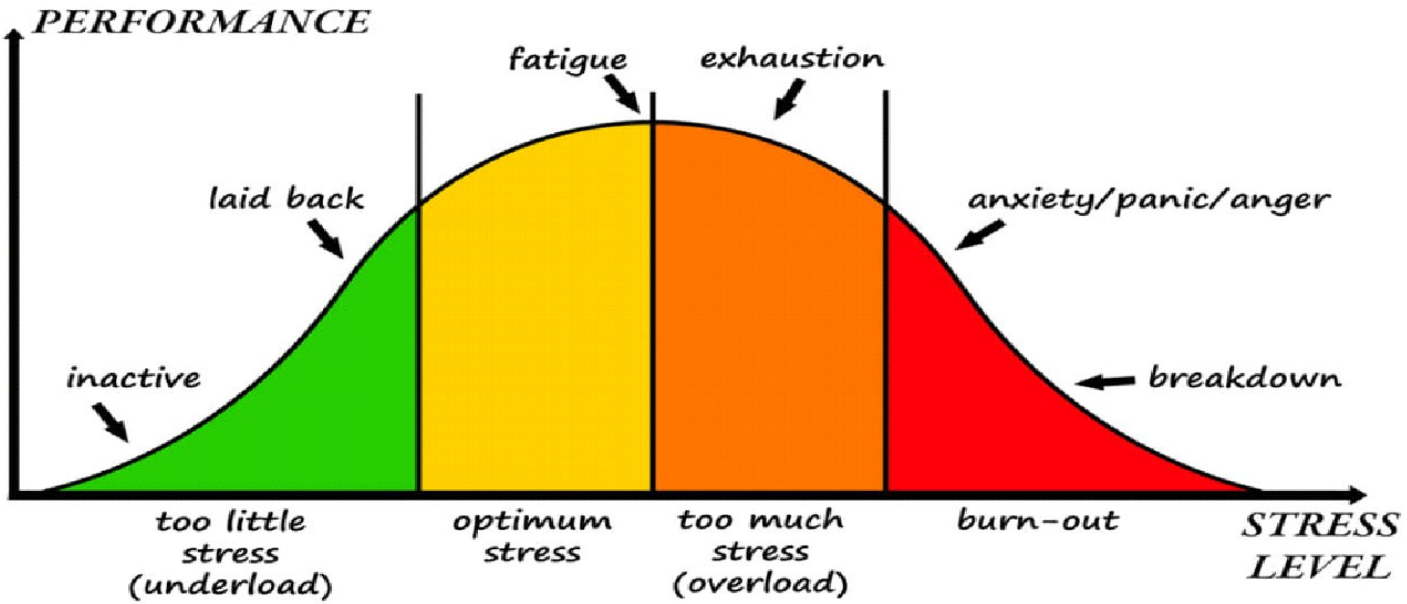
Biopsychosocial Model for Healthy Dancing



One way to control injury is to Manage your body's budget

- Stress
- Sleep
- Nutrition
- exercise

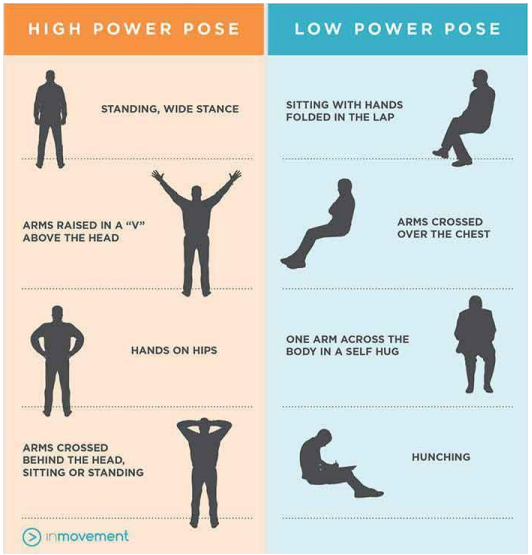
Stress: Good or Bad?



- Stress is not necessarily good or bad, but is on a continuum and should be managed.
- Healthy stress is beneficial vs. too much stress leads to distress
- Optimal stress is sustainable

How can you have better resili

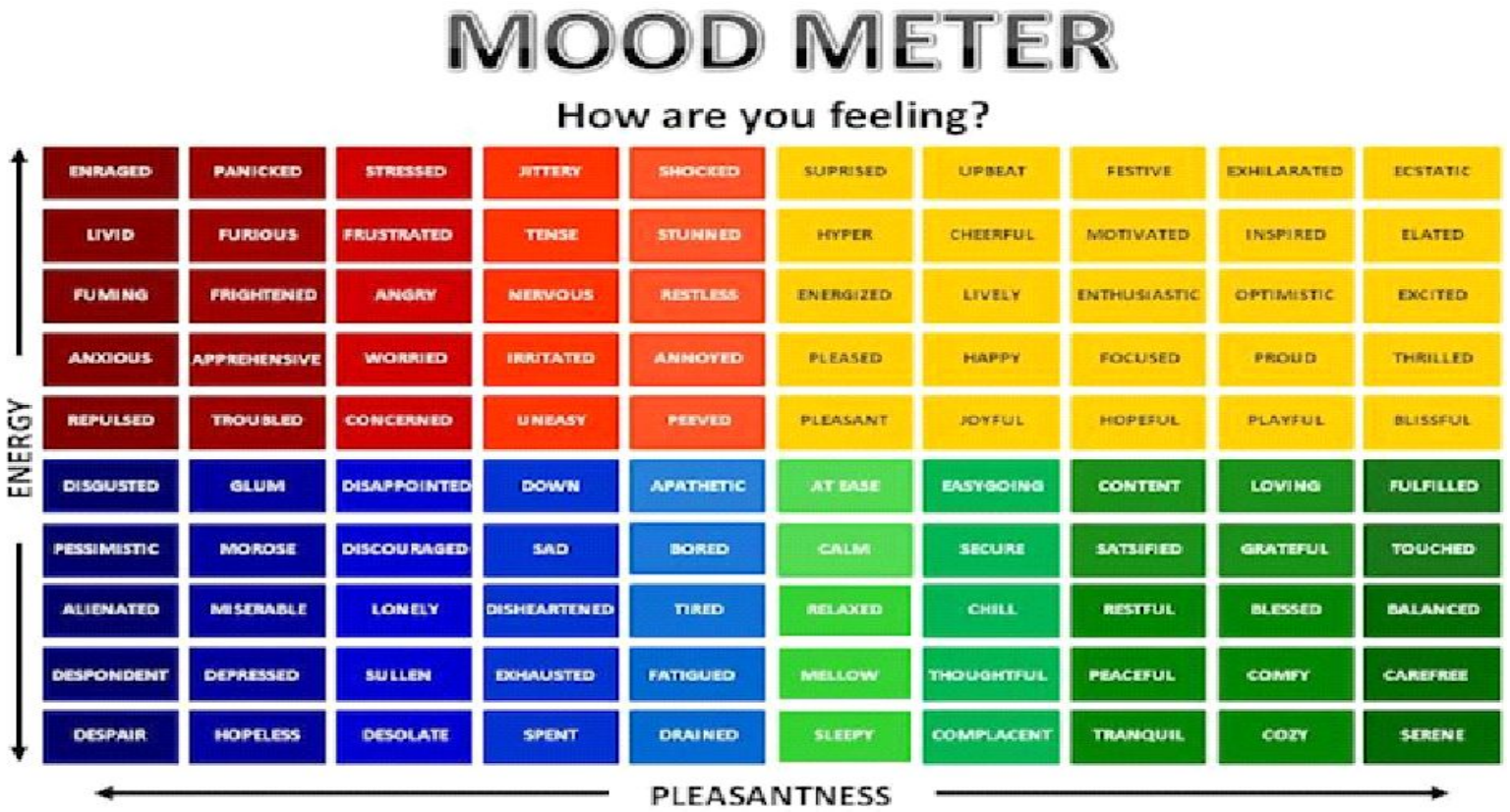
Power Pose: neutral pose, over a closed or contracted pose



Smile

- Facial expression can boost mood
- Sends stress reducing chemicals to the brain to bring sense of mild euphoria.
- It's contagious
  - stimulate mirror neuron cells
    - when we see someone happy, we smile in return
- Enhances:
  - neurological changes
  - confidence
  - endorphins

How are you feeling?
Emotional regulation: accepting a range of emotions

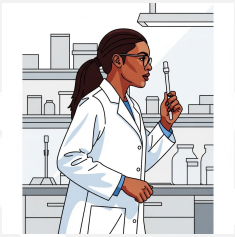


Gratitude meditation

PART 02

My work

Jump Biomechanics in dancers and athletes



The Problem

What are you studying

- Dancers do a variety of jumps
- What are the different forces of each jump?

Why is it important?

- By knowing the forces we can learn how to:
- progress jumps
- Rehabilitate dancers
- Improve performance

Gaps

- We understand that dancers get injured when landing at high forces
- But we do not have information on jump landing forces

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Solution / Purpose

- Measure a variety of jump forces
- Rank order them in a range from lowest to highest
- Group them by forces of common tasks such as
  - walking
  - Running
  - Hoping

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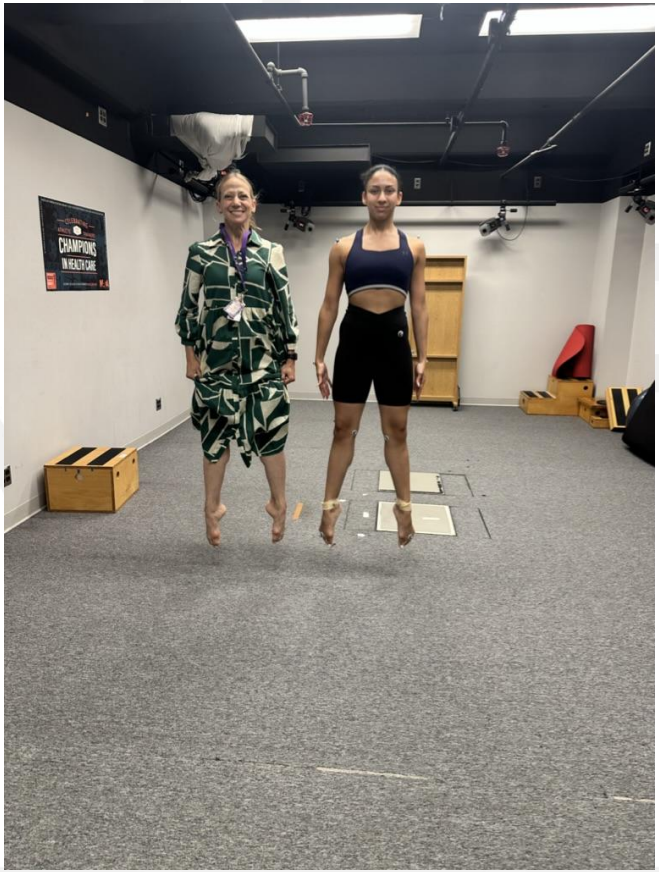

Methods

- Informed consent
- Biomechanics lab
- 28 reflective markers
- 8 cameras
- Force Plate
- 35 types of jumps
- 3 trials each
- Measure Kinetics
- Measure kinematics

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Types of jumps we chose:

- Two feet landing
- One foot landing
- Horizontal across the floor
- Vertical jumps
- Landing off a step
- Focused on 1 variable to measure

Results

NYU Langone Health

Establishing Maximal Jump Landing Force in Dancers: A Biomechanical Observation Study

HARKNESS CENTER FOR DANCE INJURIES

Emily Sandow, DPT, OCS and Sarah Edery-Altas, DPT, OCS

Harkness Center for Dance Injuries, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, NY

INTRODUCTION

- Dance is ranked as the most physically demanding job in the US with a high incidence of musculoskeletal injuries.[5,6]
- Contributing factors: volume of jumps (200/dance exposure[4]), jump vertical ground reaction forces (vGRF).
- Dance peak vGRF is reported up to 12 times body weight (xBW).
- Value may be an overestimation of max vGRF. Is inconsistent with 2–5xBW dance/sports ranges.[1,2]
- In primary source, cited over 75 times, is not vGRF but, "specific knee joint axial forces in jump landing".[3]
- Overestimation of jump forces misinterpreted and perpetuated.
- Maximal ranges of jump forces in dancers should be redefined.

PURPOSE

- The purpose of this study is to establish a new maximal landing force benchmark for dancers that is aligned with sports and dance biomechanical research.
- This is to reconcile the inconsistency between maximum jump force landings reported in the common dance literature, and that found in biomechanical jump studies.

METHODS

- This is an IRB approved observational cross-sectional cohort study of 12 healthy 18–49 year old dancers performing 35 types of jumps at maximal force on an AMTI force plate.
- A two-sided Wilcoxon signed rank test for comparing whether the average of each maximum jump force equals 12 returned a p-value <0.01 for each jump, meaning all 35 jumps were significantly different than 12xBW.
- In descriptive statistics, the jumps with maximum vGRF were grand jete and bilateral squat jump at 3–4xBW.

Main Finding: Maximal Jump Force Landing in Dancers is 4 times body weight

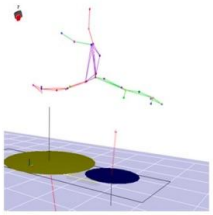

Figure 1. Grand Jete Force landing

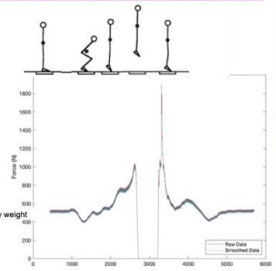

Figure 2. Squat jump vGRF

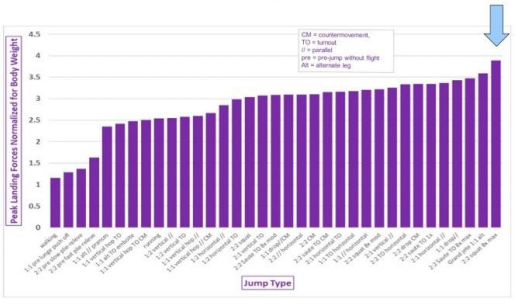

Table 1. Range of peak jump landing forces normalized for body weight

RESULTS

- Maximum vGRF measured from a variety of 35 jumps was 4xBW.
- This is a counterpoint to existing dance literature citing 12xBW, a value that has been misconstrued and repeatedly reported in dance literature.

CONCLUSIONS

- **Results of this study establish the current maximal jump landing force in dancers as 4 times body weight.**
- This range is more consistent with sports and dance literature and more accurately represents jump landing forces in dancers.
- Our goal is to improve the clarity and accuracy of jump forces to be used as a benchmark for reporting in dance science, dance training, and return to dance rehabilitation.

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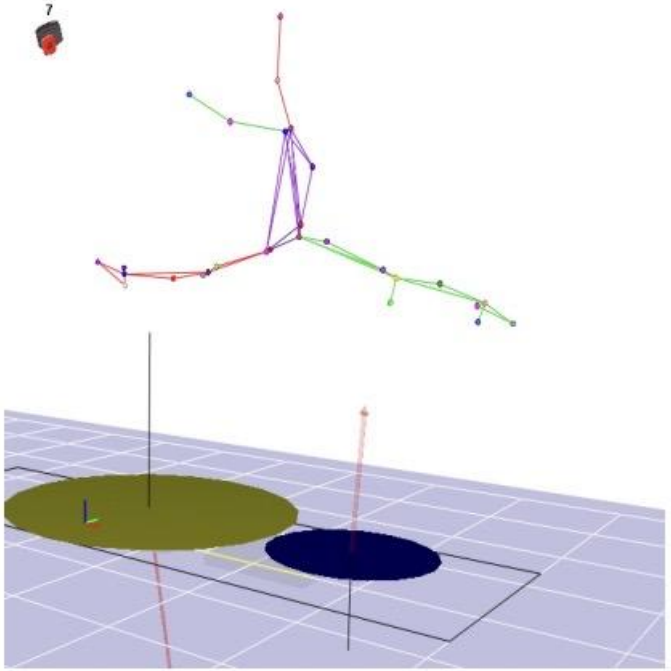
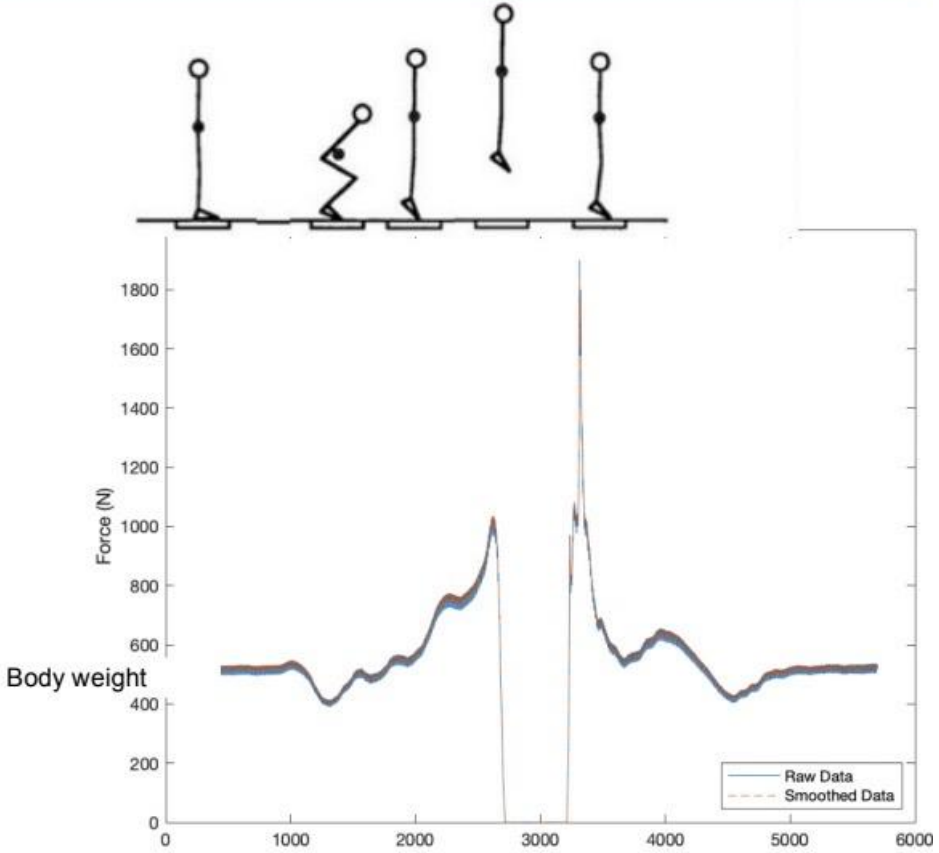
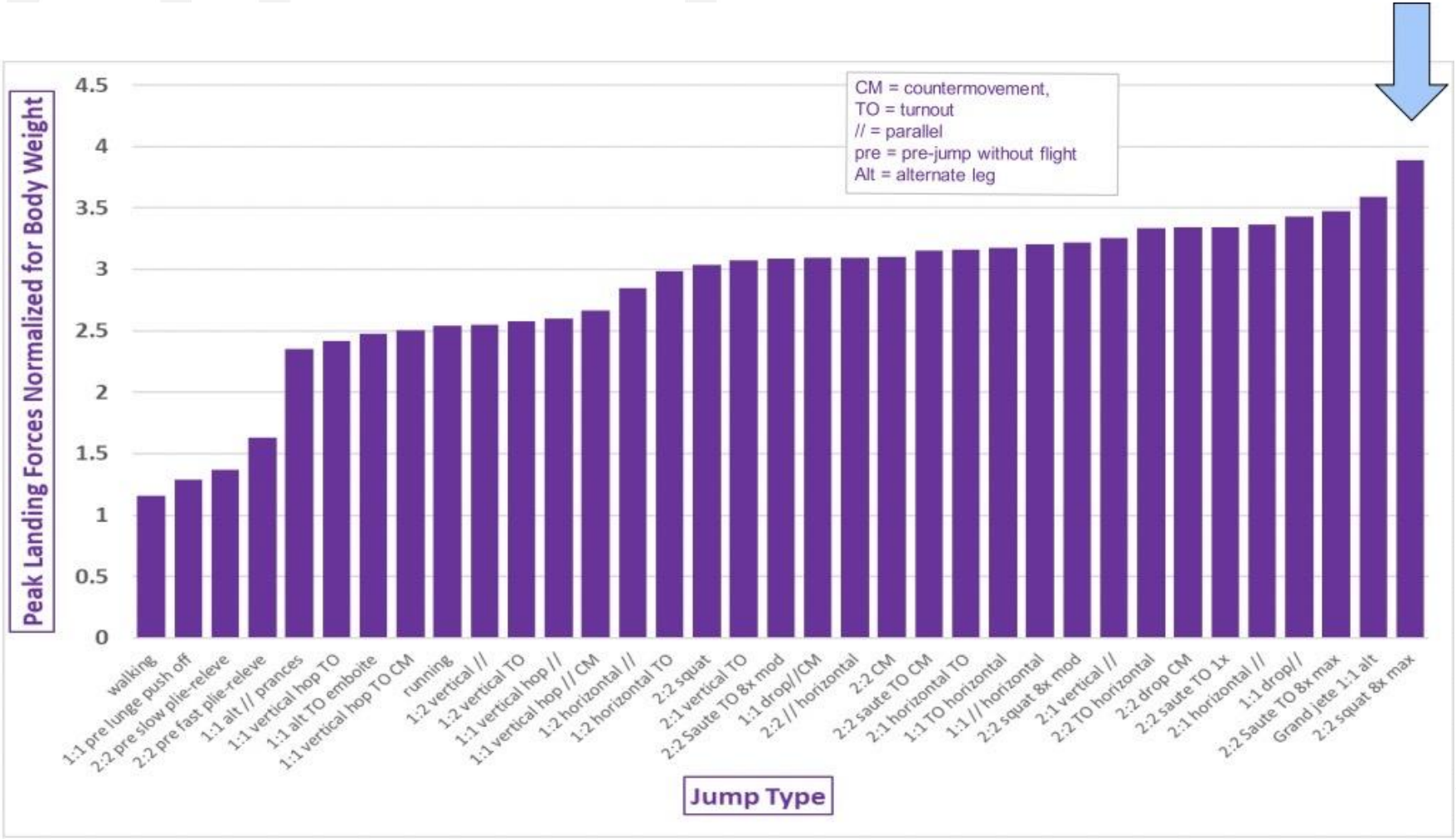
Disclosure: **Emily Sandow and Sarah Edery-Altas have no financial disclosures that would be a potential conflict of interest with this presentation.**

Main Finding: Maximal Jump Force Landing in Dancers is 4 times body weight






Peak Landing Forces Normalized for Body Weight
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
CM = countermovement,
TO = turnout
// = parallel
pre = pre-jump without flight
Alt = alternate leg
walking
1:1 pre lunge push off
2:2 pre slow plie-releve
2:2 pre fast plie-releve
1:1 alt // prances
1:1 vertical hop TO
1:1 alt TO emboite
1:1 vertical hop TO CM
running
1:2 vertical //
1:2 vertical TO
1:1 vertical hop //
1:1 vertical hop // CM
1:2 horizontal //
1:2 horizontal TO
2:2 squat
2:1 vertical TO
2:2 Saute TO 8x mod
1:1 drop//CM
2:2 // horizontal
2:2 CM
2:2 saute TO CM
2:1 horizontal TO
1:1 TO horizontal
1:1 // horizontal
2:2 squat 8x mod
2:1 vertical //
2:2 TO horizontal
2:2 drop CM
2:2 saute TO 1x
2:1 horizontal //
1:1 drop//
2:2 Saute TO 8x max
Grand jete 1:1 alt
2:2 squat 8x max
Jump Type

PART 02

Closing the loop

What is the impact of what you found

- We looked measured 1 feature of a jump
- We can train dancers at low, moderate, and high impact jump forces

How does it change practice?

- Consider jumping earlier in rehabilitation

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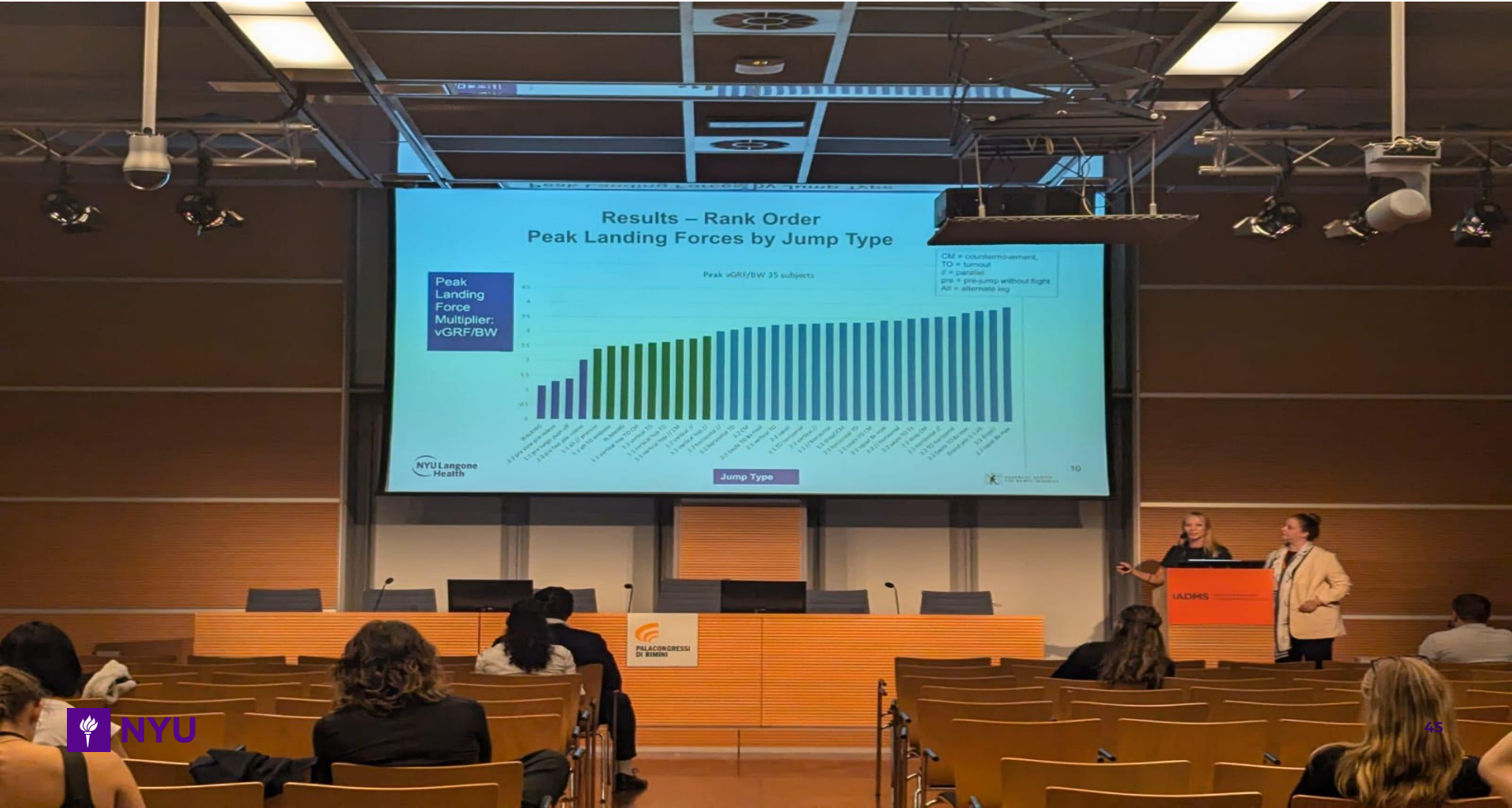
Results – Rank Order
Peak Landing Forces by Jump Type
Peak Landing Force Multiplier: vGRF/BW
Peak vGRF/BW 35 subjects
CM = countermovement,
TO = turnout
// = parallel
pre = pre-jump without flight
Alt = alternate leg
Jump Type
NYU Langone Health
10
PALACONGRESSI DI RIMINI
IADMS

PART 03

Activity

PART 03

Lets apply our new knowledge in an activity

- Measure balance on one leg?
- Why do we want to know this?
- Methods:
  - Consent from participant
  - Timers
  - Judges
  - Two conditions:
- Record findings
- Explain your findings

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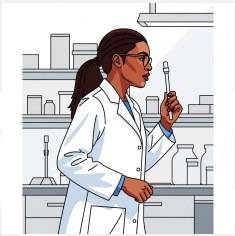
PART 02

My work

Stress Urinary Incontinence in Impact Athletes



From the Ground Up: Managing Pelvic Floor Dysfunction in Athletes and Dancers

Understanding the prevalence, cause, and solution

Dr. Emily Sandow, DPT OCS

NYU Steinhardt

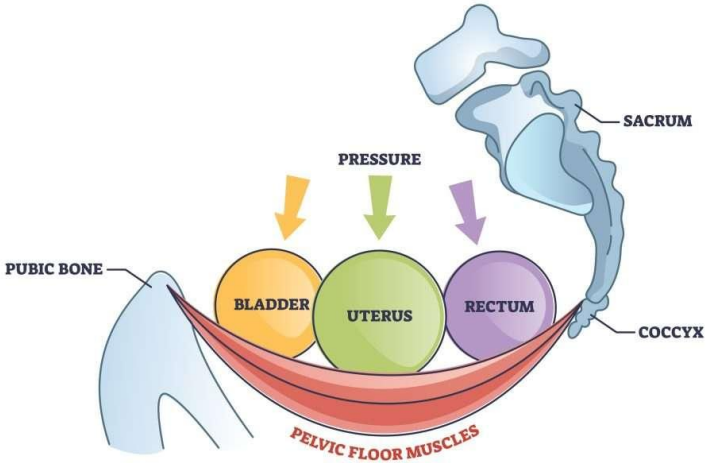
Hunter College - City College of New York

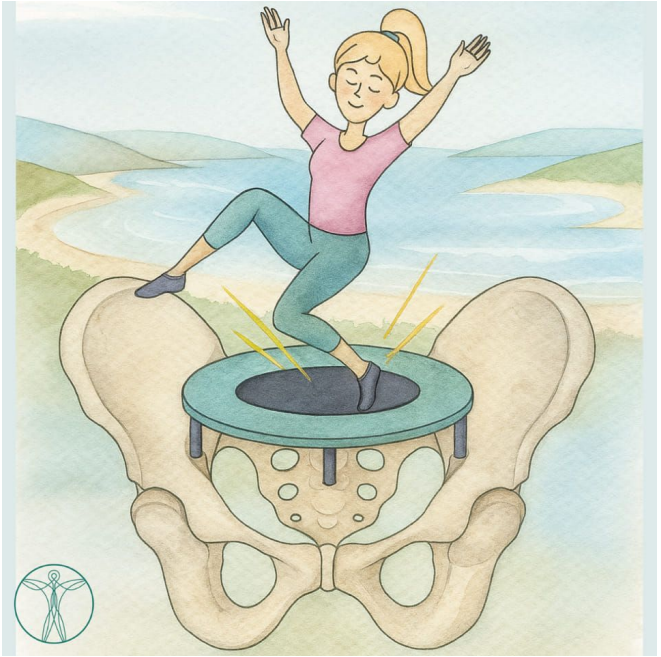
NYU Langone Health

SUI or TMI?


2025...the year to be proud of your pelvic floor 🙌
Follow
myself.
Likes
427

What is the pelvic floor?

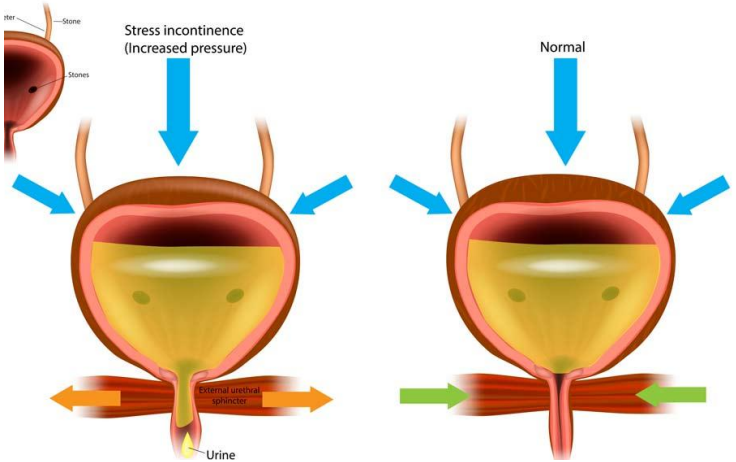




Definitions:

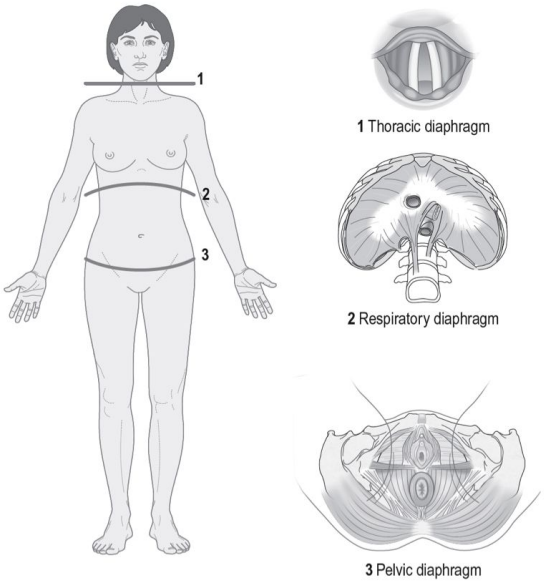
Stress Urinary Incontinence (SUI)

- Involuntary leaking of urine when performing a physical activity
- Hammock Hypothesis
  - The pelvic floor is like a hammock supporting pelvic organs.
  - Need strong tissue below the bladder neck during increased intra-abdominal pressure
  - Lack of contraction of the detrusor muscle that contains the bladder
  - Results in urinary leakage



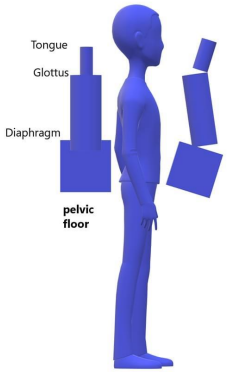
Pressure Management vs Force Absorption

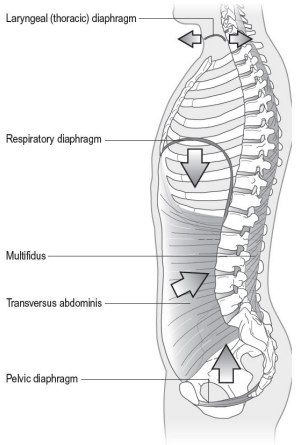
Anatomy: Connection between Breath and Pelvic Floor



How does the Pelvic Floor respond to breath

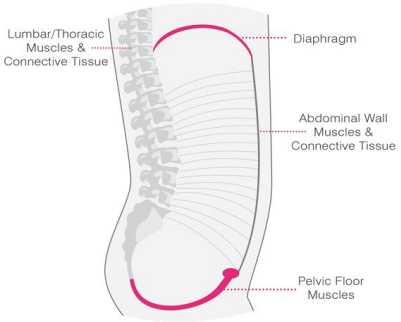
1. Every breath creates a wave-like movement
2. With inhale, diaphragm moves down, increasing pressure in abdominal cavity and pelvic floor descends to balance the pressure
3. on exhale, the diaphragm moves up and pelvic floor contracts slightly to assist in releasing pressure
4. Disruptions: shallow chest breathing, excess tension, poor posture create imbalances





Definitions:
What is intraabdominal pressure and why does it matter?

- The amount of pressure in the abdominal cavity
- Changes in response to respiratory phase and abdominal wall resistance.
  - Should maintain constant amount of pressure.
- Want appropriate amount of stiffness in the abdominal cavity for the anticipated activity



Core Activation: The 'Expansion and Compression' cycle of the Core driven by the breath

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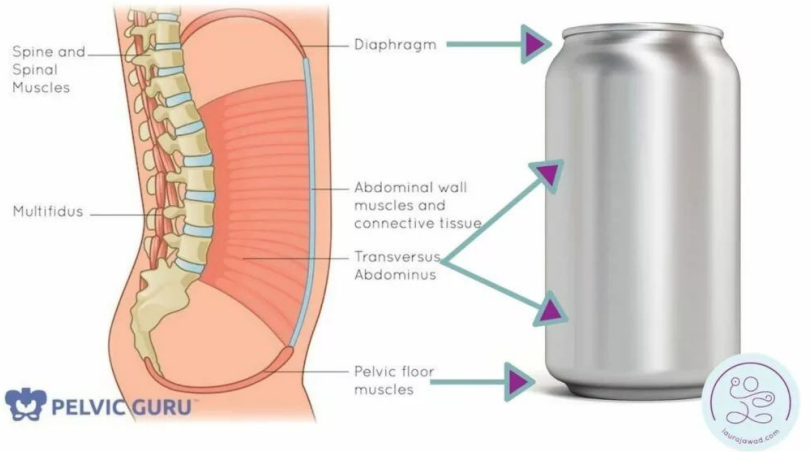
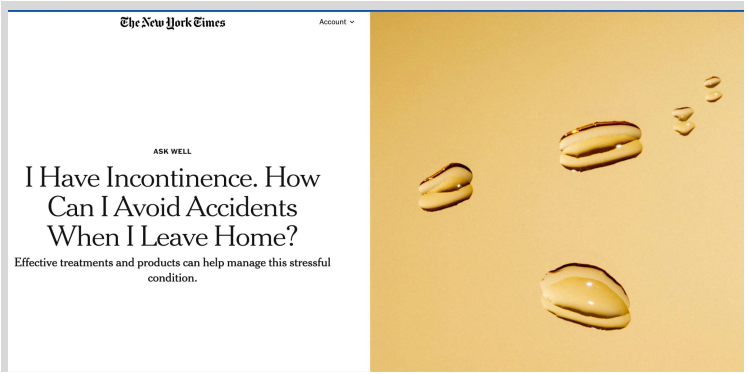


We can finally talk about incontinence



Prevalence:

Why should we think about Stress Urinary Incontinence in athletes?

- Elderly and Child-bearing women: 4-35% (Luber 2004)

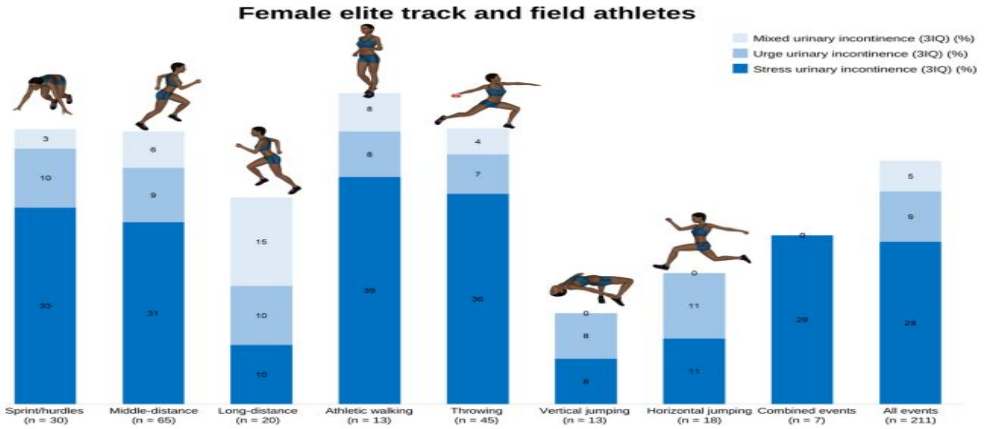
- Stress Urinary Incontinence affects 34% of nulliparous women between the ages of 18-60 (Nygaard 2005)

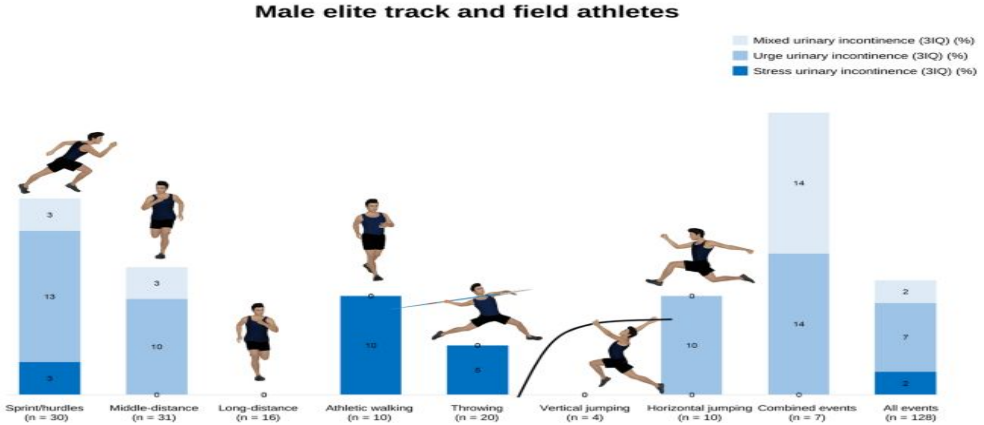
- General population: 7% of non-pregnant Women <39 years of age
- 1 in 3 women over age 40 report leaking associated with laughing, sneezing, coughing (Coyne 2009)
- Athletes: 13-80% of female impact athletes (Dias 2017; Teixeira 2018)
- Dancers: 35%
    - Based on survey of 208 female professional dancers (Winder 2022)

Prevalence:

Why should we think about Stress Urinary Incontinence in athletes?

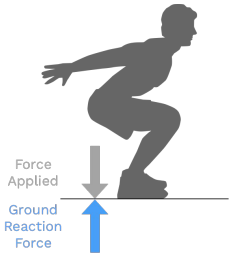
- Impact athletes:
  - Individuals who participate in sports involving repetitive or high-impact movements
- Causes increased pressure on the pelvic floor muscles
- Higher prevalence in females
- Risk factors in high impact athletes:
  - **Exercise Overload**:
    - Strengthens, to a limit, then can weaken PFM
  - **Fatigue of the PFM:**
    - Female triathlons, ironman, distance runners
  - **Force absorption**:
    - Impact activity: Gymnasts and trampoline athletes

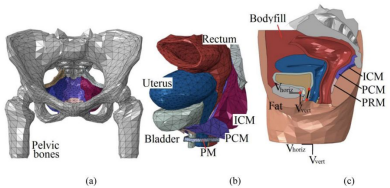




Cause:
Stress urinary incontinence is unique in impact athletes

- A computational simulation of the female pelvic floor (Dias, 2017)
- **General population**
  - Coughing: 1 peak increase intra-abdominal pressure (IAP)
- **Female impact athletes**
  - Jump landing
  - Two peaks of pressure
    - 1st peak contact with the floor
    - 2nd peak is delay of the bladder rebounding





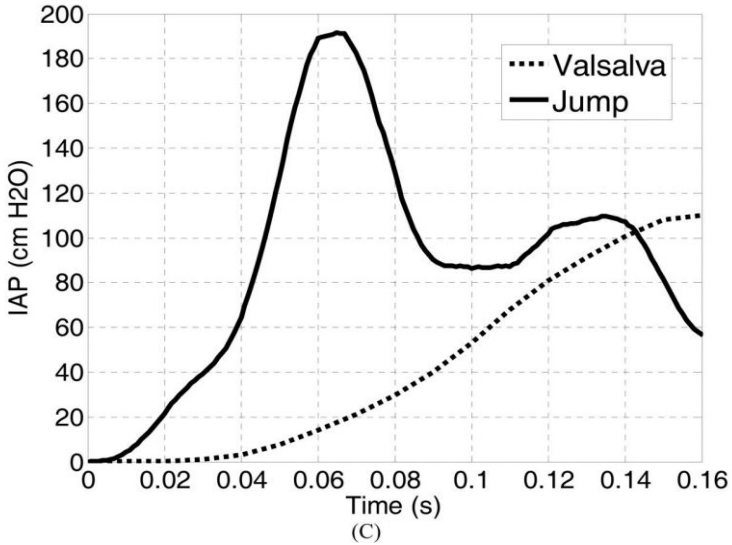
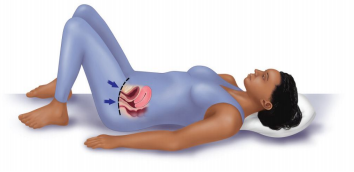


Figure 5.
The comparison of the pelvic floor deformations between (a) jumping and (b) Valsalva at maximal IAP. The comparison of the IAP history plots of jumping and Valsalva was shown in (c).

Treatment:
History of Pelvic Floor Muscle Training (PFMT)



Chinese medicine

Part of exercise programs in Chinese Taoism for over 6,000 years (Chang, 1984)

Dr. Arnold Kegel

Dr. Arnold Kegel, American GYN recommended PFM exercises with pressure biofeedback as treatment of SUI in females. (Kegel, 1948)

PFMT in female athletes: increases PFM strength and decreases urine leakage. Should be used to prevent and treat PFD in athletes.

(Systematic review, Rodriguez-Longobardo, 2024)

6,000 years ago

1936

Pelvic Floor exercises
Western Medicine described tensing and relaxing pelvic floor muscles to prevent and treat urinary and fecal incontinence (Morris 1936)

1948

2017

International Standard

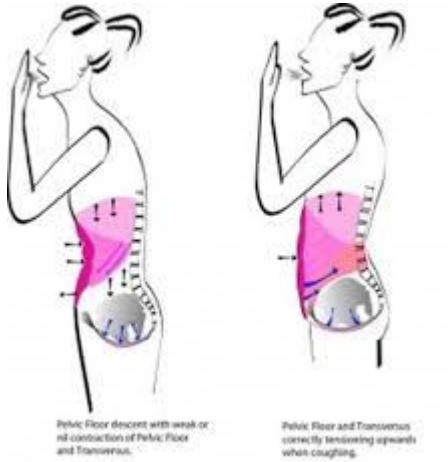
2017 PFMT became international standard as an exercise to improve pelvic floor muscle strength, endurance, power, relaxation. (Bø 2017)

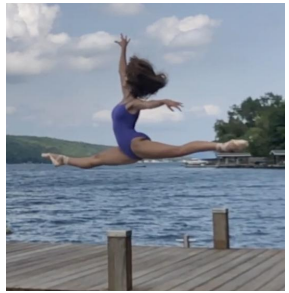
2024

Treatment: Beyond the Kegel
When to do these exercises?

- Warm up:
  - Dedicated Pelvic Floor Muscle Training before exercise
    - (Cross 2023)
- Timing of contraction:
  - Feed-Forward: Anticipate the task before impact
  - The “Knack”:
    - A counter-balance voluntary PFM contraction prior to landing
    - This method is knows a "bracing" yourself by squeezing up and holding your pelvic floor muscles before you cough, laugh, sneeze, or lift anything that would cause you to leak

(Kibler 2006, Dias 2017; DeLancey 1988; Bø 2001; Pontbriand-Drolet 2012; Bo 2004; Bø 2007; Miller 1998; Carrière 2006; Miller 1998; Dumoulin 2018 Cochrane Systematic Review)





Take Aways:
Managing Stress Urinary Incontinence in athletes

- Prevalence of Stress Urinary Incontinence
  - Stress Urinary Incontinence is prevalent in dancers and impact athletes

- Cause of Stress Urinary Incontinence
  - The mode of SUI is unique in impact athletes with two peak forces.

- Treatments of Stress Urinary Incontinence:
  - There are known biomechanical relationships between foot and PFM
  - Beyond the Kegel: there are broad benefits of PFM training on SUI

With an established relationship between the foot and pelvic floor, controlling contact with the floor can be the most effective training for athletes with symptoms of stress induced incontinence.

J Dance Med Sci. 2010;14(3):82-8.

Functional criteria for assessing pointe-readiness

Megan Richardson [1], Marijeanne Liederbach, Emily Sandow

Affiliations + expand

PMID: 21067685

Abstract

The most popular criterion cited in the dance literature for advancement to pointe work is attainment of the chronological age of 12 years. However, dancers at this age vary greatly in terms of musculoskeletal maturity and motor skill development. The purpose of this study was to investigate whether objective, functional tests could be used in conjunction with dance teacher expertise to determine pointe-readiness. It was hypothesized that dynamic tests of motor control can better indicate pointe-readiness than chronological age alone or in combination with static musculoskeletal measurements. Thirty-seven pre-pointe students from two professional ballet schools were tested for muscular strength, ankle joint range of motion, single leg standing balance, dynamic alignment, and turning skill. In addition, the participating students' ballet teachers independently graded each student on her readiness to begin dancing en pointe. Performance on three functional tests (the Airplane test, Sauté test, and Topple test) was closely associated with teacher subjective rating for pointe-readiness. It is concluded that these tests may be more useful for gauging acquisition of the skills required for safe and successful performance than the traditionally accepted indicators of chronological age, years of dance training, and ankle joint range of motion.

Case Reports > J Dance Med Sci. 2011 Mar;15(1):37-44.

Case studies in cervicothoracic spine function evaluation and treatment of two dancers with mechanical neck pain

Emily Sandow [1]

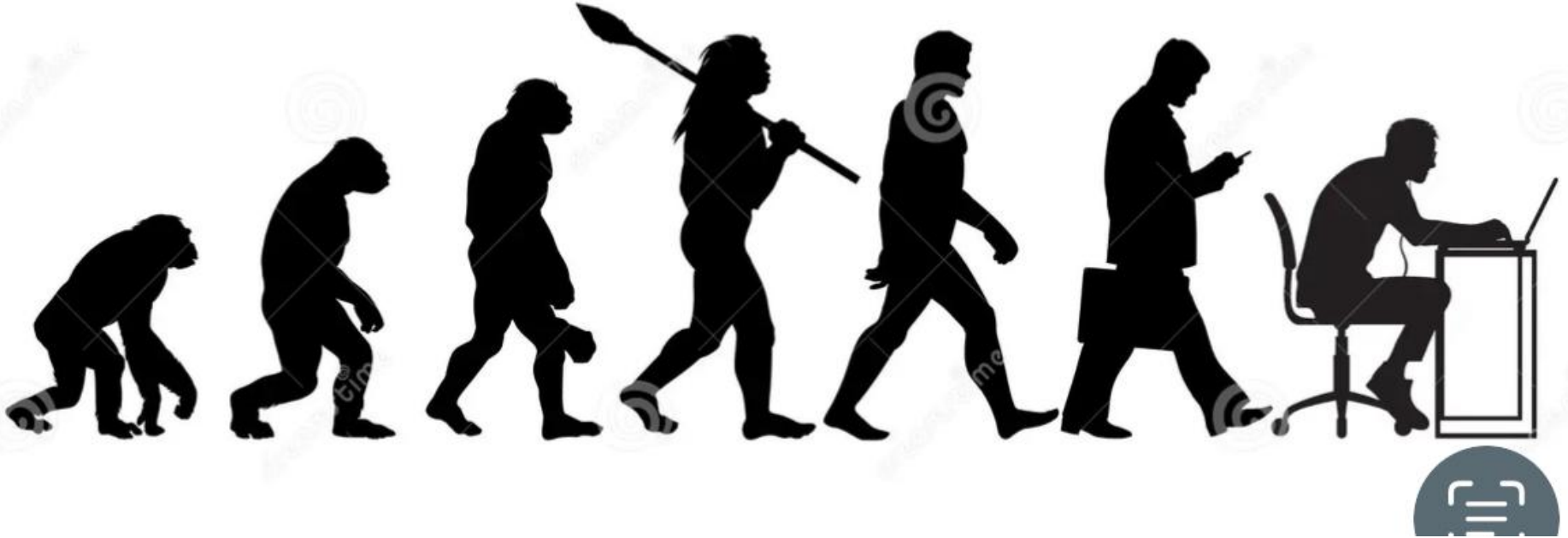
Affiliations + expand

PMID: 21703092

Abstract

It has been reported that manual therapy directed at the thoracic spine followed by exercise may improve outcomes in patients with mechanical neck pain. At this point, there is little available data on dancers with neck pain, and it is unclear whether this type of treatment is appropriate for restoring the rigorous level of activity required of the dancer. The purpose of this study was to review the evaluation, clinical decision-making process, and treatment of two dancers-one with acute and the other with chronic neck pain-who fell into the classification of patients who might benefit from an intervention to the thoracic spine. The two participants were a musical theater dancer with an acute onset of neck pain and a retired dancer who was an active dance company director with an 11-year history of chronic neck pain. Both participants went through a standard examination and were treated with mobilizations to the upper thoracic spine followed by therapeutic exercises. In both cases, successful outcomes were achieved immediately after treatment and up to six months after discharge from physical therapy.

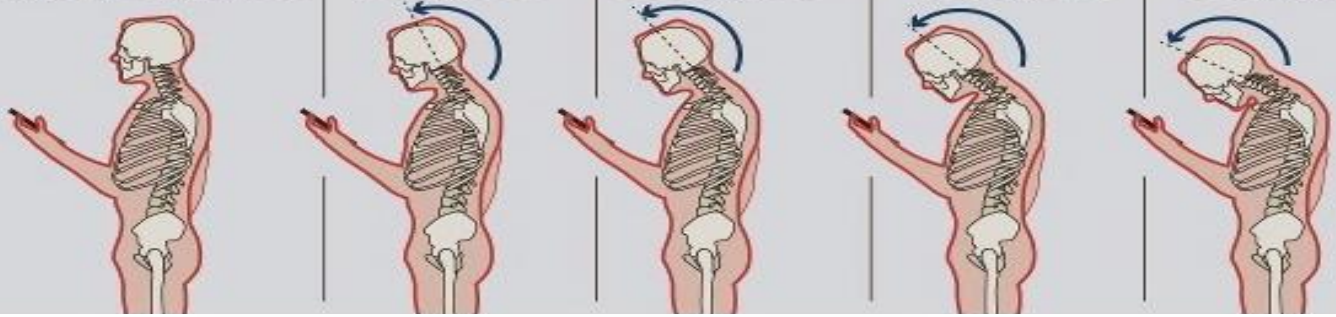
Posture

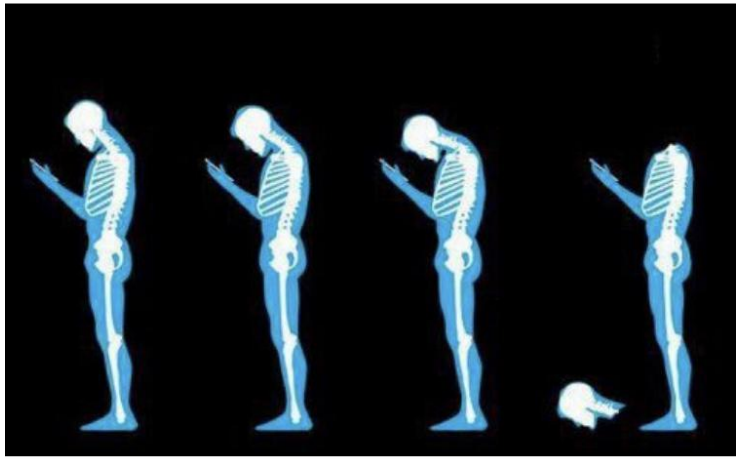


How texting could damage your spine

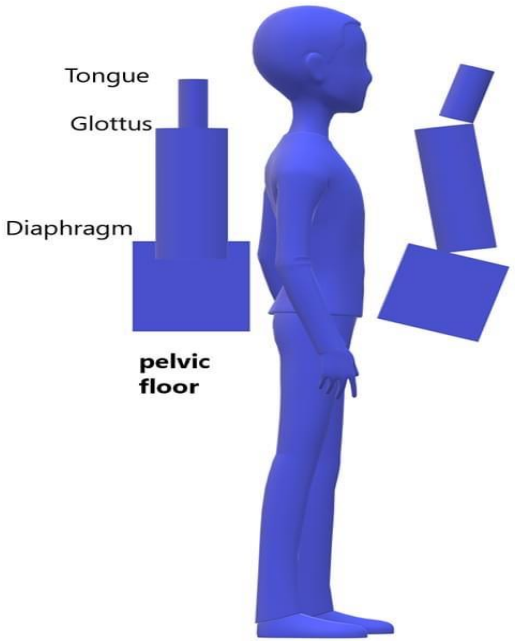
Forces on the neck increase the more we tilt our heads, causing spine curvature

Force on neck	10-12lb	27lb	40lb	49lb	60lb
Neck tilt	0 degrees	15 degrees	30 degrees	45 degrees	60 degrees





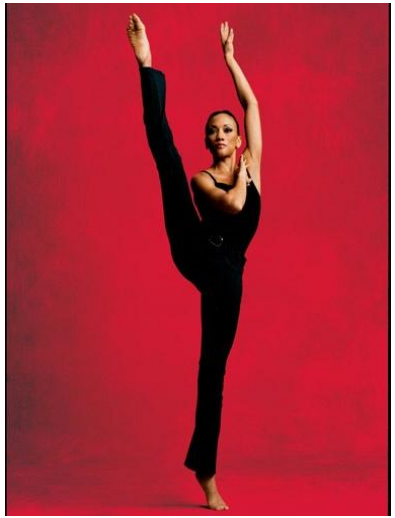
Posture



The Washington Post
Democracy Dies in Darkness

‘Horns’ are growing on young people’s skulls. Phone use is to blame, research suggests.

Question: How can we make dancers fitter, healthier, and less prone to injuries?



QUESTIONS?

- Dr. Emily Sandow, DPT, OCS