

THE GRADUATE COLLEGE OF THE  
UNIVERSITY OF OKLAHOMA HEALTH SCIENCES CENTER

ANNOUNCES THE FINAL EXAMINATION OF

# Kimberly Perrella Veirs

FOR THE DEFENSE OF THE DOCTOR OF PHILOSOPHY DEGREE  
GRADUATE COLLEGE

*Department of Allied Health Sciences*

Monday, November 18, 2019 | 7:00 am  
Allied Health Building, Room 3025



*EVALUATION OF THE EFFECTS OF FIRST METATARSOPHALANGEAL JOINT  
MOBILITY ON THE YOUNG BALLET DANCER'S ABILITY TO ASSUME THE EN  
POINTE POSITION USING A MULTI-SEGMENT FOOT MODEL*

**COMMITTEE IN CHARGE:** Carol P. Dionne, DPT, PhD, Chair; Andrew Fagg, PhD; Amgad Haleem, MD, PhD; Lynn Jeffries, PT, PhD; Kenneth E. Randall, PT, PhD; Susan Sisson, RD, PhD

**ABSTRACT:** *Background:* Ballet dance requires excessive, repetitive range of motion (ROM) at the foot-ankle complex, possibly contributing to high rates of injury. Nevertheless, little information is known concerning the *in vivo* kinetics and kinematics of the foot-complex during dance-specific movement. This dissertation encompasses a pre-dissertation survey study and two biomechanics studies examining cohorts of ballet dancers' shod *en pointe* (standing in pointe shoes on straight toes with maximum ankle plantar flexion). The purpose of the primary dissertation study was to examine how adolescent, novice dancer's ability to assume an upright posture in pointe shoes affects dancer-specific biomechanics, particularly the amount of first Metatarsophalangeal (MTP) ROM. A pilot study compared ROM of elite ballet dancers during barefoot (BF) and shod *elevé en pointe* (rising onto toes with straight, externally rotated legs) to describe which condition resulted in greater movement at six single-plane joint segments and four tri-planar intersegments using a modified Rizzoli 3D multi-segment foot model. This initial study informed the primary dissertation study.

*Methods:* For both biomechanics' studies, Qualisys™ 3D motion capture and AMTI force plates recorded dancers performing first position *elevé en pointe*. The novice dancer study evaluated 11 variables, including the five most significant variables from the pilot study, and compared dancer's ability to stand upright "on-the-box" of the pointe shoe as per a plumb-line (Group 1: on-the-box; Group 2: not-on-the-box).

*Results:* Eleven elite and 26 novice healthy female ballet dancers participated in each respective study. A significant difference between novice dancer groups in first MTP-ROM at peak BF *relevé* (MedGroup1: 90°, IQR:80°-90°; MedGroup 2:70°, IQR: 70°-80°,  $p < 0.0001$ ) was observed.

*Conclusions:* Dancers able to get on-the-box of the pointe shoe (Group 1) demonstrate greater first MTP extension ROM during barefoot *relevé* than dancers unable to assume on-the-box of the pointe shoe (Group 2). Weight-bearing first MTP extension ROM could be a useful tool in predicting pointe readiness of the novice ballet dancer. This dissertation work intends to furnish clinicians and researchers with new knowledge of biomechanical factors that facilitate the determination of pointe readiness and injury risk factors of young, female ballet dancers.