

EFFECTS OF FIRST METATASOPHALANGEAL JOINT MOBILITY ON YOUNG BALLET DANCER'S ABILITY TO ASSUME *EN POINTE*

KP Veirs, MPT, PhD, ATC¹; Josiah Rippetoe, BS¹; Jonathan D. Baldwin, MS, CNMT²; Kaitlin Lutz, SPT¹; Amgad Haleem, MD, PhD³; CP Dionne, PT, DPT, PhD, MS, OCS, Cert MDT¹

Department of Rehabilitation Sciences, College of Allied Health, OUHSC, Oklahoma City, OK¹;
Department of Medical Imagery, College of Allied Health, OUHSC, Oklahoma City, OK²
College of Medicine, OUHSC, Oklahoma City, OK³

Background: Dance movement requires excessive, repetitive range of motion (ROM) of the foot and ankle, possibly contributing to high injury rates among dancers. Most injuries sustained by female ballet dancers are caused by overuse and coincide with the time they start dancing *en pointe* (standing on the toes in pointe shoes with maximum flexion of the ankle joint and toes in neutral position relative to the long axis of the foot). Yet, there are no universally accepted requirements or uniform protocols to determine when dancers can safely commence pointe. This raises safety concerns within the field of dance medicine, particularly for young dancers during critical times of skeletal development.

Purpose: The purpose of this study was to examine how novice dancers' ability to assume upright posture in pointe shoes affects dancer-specific biomechanics.

Methods: Qualisys™ 3D motion capture recorded dancers performing 10-15 repetitions of first position *elevé en pointe* (rising onto pointe by plantar-flexing or pointing the ankle and foot while keeping the knees and hips straight in external rotation and the trunk upright) using a modified Rizzoli multi-segment foot model. Dance-specific posture assessment included barefoot weight-bearing first metatarsophalangeal (MTP) joint extension measurement and total body plumb-line evaluation standing parallel *en pointe* (shod). Dancers were stratified into two groups based on ability to stand on-the-box of the pointe shoe (Group 1: on the box [n=11]; Group 2: not on the box [n=15]). Comparison of 8 kinematic and 3 kinetic variables aimed to describe group differences during shod *elevé* and in *relevé* (balancing in *elevé en pointe*). Wilcoxon Signed-Rank test assumed no difference between groups using Bonferroni correction ($p < 0.0045$) for each of the 11 variables tested.

Results: Investigators observed significant difference between groups in first MTP-ROM at peak barefoot *relevé* (Med_{Group 1}: 90°, IQR: 80°-90°; Med_{Group 2}: 70°, IQR: 70°-80°, $p < 0.0001$). Investigators found no differences in C7 displacement (m) and ankle and hip moments (Nm/kg) at peak shod *relevé*, indicating both groups tend to engage the same dominant muscle groups (trunk extensors [$p = 0.50550$], ankle dorsiflexors [$p = 0.1484$], hip flexors [$p = 0.8785$], and hip abductors [$p = 0.8785$]).

Discussion/Conclusion: Novice dancers on-the-box of the pointe shoe demonstrated greater weight-bearing first MTP-ROM than dancers not on-the-box. Thus, weight-bearing first MTP-ROM could be useful in predicting pointe readiness. Although other variables tested were not statistically different between groups, interesting trends were observed and will be discussed.

Relevance to Allied Health: Rehabilitation specialists who treat dancers must understand the unique biomechanics of the dancers' foot to appropriately treat this specialized population. Weight-bearing first MTP extension ROM could be a useful tool in predicting pointe readiness of the novice ballet dancer. This study intends to furnish clinicians and researchers with new knowledge of biomechanical factors that determine pointe readiness and injury risk factors of young, female ballet dancers.