Injury Risk Cut-offs for Bone Density and Body Composition in Professional Female Ballet Dancers.

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Introduction: Female professional ballet performers are a unique population that undergo substantial physiologic stresses related to training, performance, and, at times, reduced energy availability that can result in elevated incidences of injury relative to their male counterparts and, even more so, the general population. However, there are currently no population-specific cut-offs based on dual energy X-ray absorptiometry (DEXA), bone mineral density (BMD), bone mineral content (BMC), and body composition (lean mass, LM; fat mass, FM) in relation to injury risk for appropriate screening and identification of those who might benefit from nutritional or activity-based interventions for injury prevention. The purpose of this investigation was to develop population-specific DEXA cut-offs for BMD and body composition in professional female ballet performers based on injury risk. **Methods:** All procedures for this investigation were approved by the IRB. A total of 132 DEXA scans among 48 female professional ballet dancers from a single dance company taken during yearly physicals between 2017-2022 were collected for BMD and body composition (body mass, lean mass, fat mass). The electronic hospital record (EHR) was reviewed for each performer. The year of injury, level of injury, anatomic location, and diagnosis were collected if an injury was identified for the year following DEXA and physical. Level of injury was recorded. The data was de-identified and categorized by gender and year of injury. A female ballet population-matched Z-score was generated for total and regional BMD and body composition measures whereby Zb = (Measure – Ballet Population Measure) / SD of the ballet population. Logistic regression was used to determine Zb-score cutoffs whereby a significant increase in injury metrics (frequency & severity) would occur. Next, a T-test was used to compare injury severity scores between those above and below the cut-off. Chi-square analysis was then used to compare injury level frequencies between those above and below the cutoff. Significance was set at $p<0.05$ for all analyses. Corresponding BMD and body composition measures to each established Zb cut-off were also calculated. **Results:** Analysis revealed a strong association between Zb-scores for body mass index (BMI, kg/m^2) and increased incidence of level 1 injuries. Weaker associations for Zb-scores for total BMD and total lean mass index (LMI, kgLM/m^2) with all-cause injury severity and frequency rates ($P<0.05$) were also found. For total BMD, a Zb-score threshold of -0.5 was observed to be the point at which injury severity ($P=0.039$) and frequency of higher-level injuries (Level 2& 3, $P<0.05$) was observed to significantly increase. This cut-off corresponded to a total BMD value of 1.100 g/cm^2. For total LMI, a Zb-score threshold of -0.5 was observed to be the point at which injury severity ($P=0.046$) and overall injury frequency ($P=0.023$) was observed to increase. This cut-off corresponded to a total LMI value of 13.86 kgLM/m^2. For BMI, a Zb-score threshold of -0.4 was observed to be the point at which injury severity ($P=0.047$) and frequency of level higher level injuries (>Level 1, $P=0.002$) was observed to significantly increase. No significant injury cut-offs for %body fat or fat mass index were observed. This cut-off corresponded to a BMI value of 18.40 kg/m^2. **Conclusions:** Reduced total bone density (BMD <1.100 g/cm^2), lean mass (LMI < 13.86 kgLM/m^2), and body mass (BMI < 18.40 kg/m^2) may increase injury risk in elite professional female ballet performers. The cut-offs identified here may be used to better evaluate injury risk (as it pertains to DEXA assessment) in a manner that is specific to this population as opposed to generalizing to general population norms. Investigation remains ongoing regarding male dancers as well as how regional DEXA measures may relate to specific injury locations.

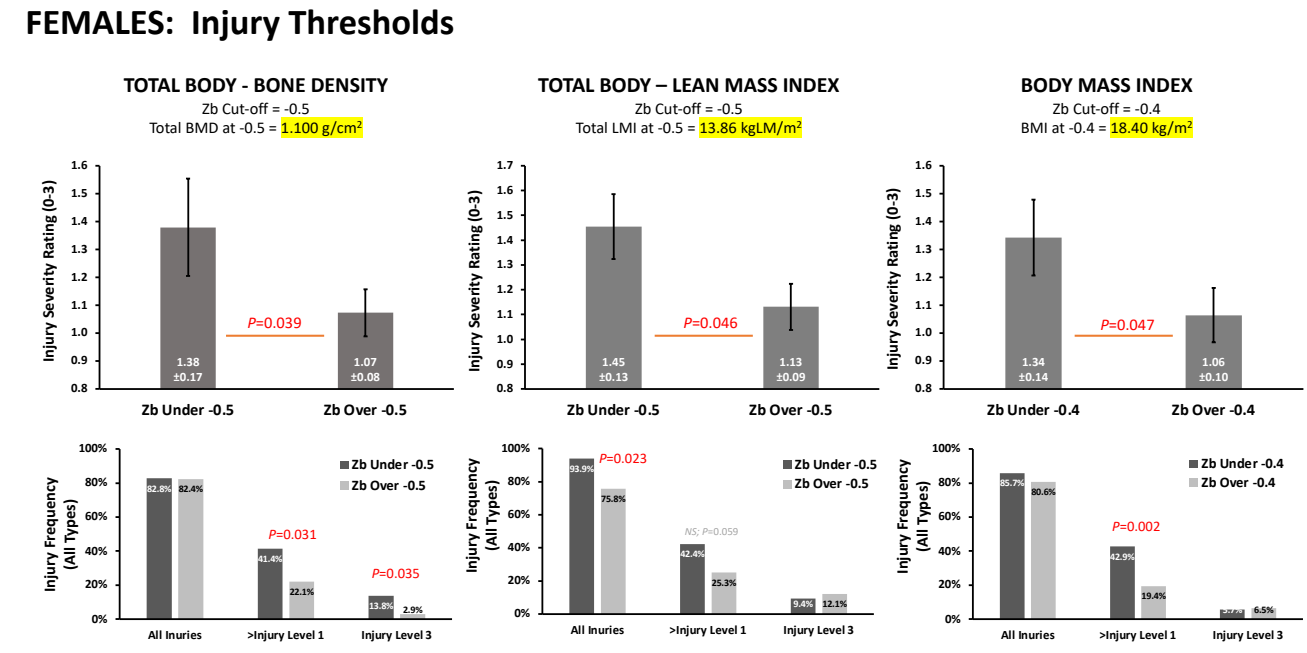

Figure 1. Female Injury Thresholds for Total Body BMD, Lean Mass Index, and BMI. Data are presented as means±95%CI for injury severity (TOP) and injury frequencies (BOTTOM) for those under vs. above the specific Zb-score injury cut-off for each measurement. *P*-values are provided for all significant pair-wise comparisons. Type-I error set at ∝=0.05.