Intrinsic Anthropometric Factors Associated with Bone Stress Injuries in Collegiate Runners: New Risk Metrics & Novel Field Screening Tools

PRANAV V. GADANGI, AARON F. CARBUHN, DANIEL YU, LAWRENCE MAGEE, PATRICK C. MCCULLOCH, BRADLEY S. LAMBERT

Orthopedic Biomechanics Research Laboratory, Department of Orthopedics & Sports Medicine; Houston Methodist Hospital; Houston, TX; Department of Dietetics and Nutrition; University of Kansas; Kansas City, KS

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Advisor / Mentor: Lambert, Bradley (bslambert@houstonmethodist.org)

ABSTRACT

Lower extremity bone stress injuries (BSI) (i.e. pelvis, femur, tibia) are common in distance running athletes relative to other sports. **PURPOSE:** To (1) characterize bone mineral density (BMD), body composition (BComp, DXA), and anthropometric parameters in D1A collegiate runners presenting with and without BSIs during a collegiate season and (2) develop BMD prediction models with an accompanying mobile application for novel noninvasive field prediction of BMD and BSI risk. **METHODS:** Distance runners (n = 79; 42♂, 37♀) from a single university track and field team were retrospectively enrolled into study. The runners completed a DXA scan during fall screening (August-November). Three months after scanning, medical records were reviewed for the occurrence of BSI confirmed by a licensed physician. A t-test was used to compare BMD (total and regional [spine, pelvis, and legs]), BComp (% body fat, fat mass, and lean mass), and anthropometric measurements (shoulder width and leg, arm, and trunk length) between runners with versus without BSI (included subgroup analysis by sex). Multiple linear regression with stepwise removal was used to determine variables most predictive of BMD. Xcode (Apple Inc.) was used to develop the mobile application based on the derived BMD prediction models utilizing lower-bound 95% confidence intervals for runner-specific BMD norms as risk cutoffs. **RESULTS:** Eighteen runners (22.8%; 11♀, 7♂) sustained a lower limb BSI. Compared to the noninjured group (NoBSI), injured runners (BSI) had lower total BMD (NoBSI: 1.24±0.02, BSI: 1.15±0.04, $p<0.001$) and regional BMD (spine -11%, legs -9%, pelvis -10%, $p<0.001$). Injured athletes were observed to have shorter leg length (NoBSI: 95.6±1.4cm, BSI: 91.9±2.6cm, $p=0.015$) and arm length (NoBSI: 56.1±0.8, BSI: 53.8±1.5, $p=0.006$). Injured males had lower fat mass (NoBSI: 7.7±0.5kg, BSI: 6.4±0.7cm, $p=0.041$) and injured females had lower leg lean mass (NoBSI: 14.7±0.6kg, BSI: 13.5±0.7kg, $p=0.035$). BComp and anthropometric measures were predictive of bone mass ($p<0.05$, $R^2=0.61$; SE= $\pm 0.27^{kg}$) and BMD (Total: $p<0.05$, $R^2=0.77$; SE= $\pm 0.05^{g/cm^2}$). $\underline{BONE\ MASS,\ kg} = (0.046 \times Age^{years}) + (0.024 \times Weight^{kg}) + (0.014 \times \%BodyFat) + (-0.017 \times Arm\ Length^{cm}) + (0.017 \times Shoulder\ Width^{cm}) + (-0.009 \times Trunk\ Length^{cm}) + (0.037 \times Leg\ Length^{cm}) - 2.867]$ | $\underline{BMD,\ g{\cdot}cm^2} = (-0.011 \times \%BodyFat) + (0.016 \times Fat\ Mass^{kg}) + (0.203 \times Bone\ Mass^{kg}) + (-0.003 \times Leg\ Length^{cm}) + 1.023$. The mobile application was able to successfully run the developed prediction models for BMD assessment. **CONCLUSION:** Collegiate distance runners with shorter limb lengths, reduced fat mass(♂), reduced leg lean mass(♀), and lower BMD are at an increased risk for a lower extremity BSI. BComp and anthropometric measures are predictive of BMD in this population and may be utilized with the mobile application developed here as a screening tool to identify potentially "at-risk" runners.