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Muscle Quantity and Bone Mineral Density Effects on Injury and Outcomes in Female versus Male Older Adult Motor Vehicle Crash Occupants

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Low muscle mass and decreased bone mineral density (BMD) have been associated with increased fracture risk and poorer in-hospital outcomes. However, the independent effects of skeletal muscle mass and BMD on injuries and hospital outcomes have been minimally studied in motor vehicle crash (MVC) occupants, and osteosarcopenia (the combination of both low skeletal muscle mass and BMD) has been studied even less.

Skeletal muscle area measurements of MVC occupants were obtained through semi-automated segmentation of an axial computed tomography (CT) slice at the L3 vertebra. An occupant height-normalized Skeletal Muscle Index (SMI) was calculated and compared to the SMI thresholds for sarcopenia in females ($< 38.5 \text{ cm}^2/\text{m}^2$) and males ($< 52.4 \text{ cm}^2/\text{m}^2$). Lumbar BMD was obtained using a validated, phantomless CT calibration. SMI and BMD predictors were first analyzed individually before being evaluated for two-way (SMI*BMD) interactions. Negative binomial regression and multiple logistic regression was used to associate SMI, BMD, and SMI*BMD predictors to injury outcomes (e.g., Injury Severity Score (ISS), maximum Abbreviated Injury Scale (MAIS) score, fractures) and hospital outcomes (e.g., length of stay, ICU days).

Of the 336 occupants analyzed, 210 (62.5%) were female and 126 (37.5%) were male, with an average \pm SD occupant age of 66.3 ± 10.6 years. SMI was $41.7 \pm 8.0 \text{ cm}^2/\text{m}^2$ in females and $51.2 \pm 10.8 \text{ cm}^2/\text{m}^2$ in males. Sarcopenia based on SMI thresholds was found in 85 females (40.5%; SMI $< 38.5 \text{ cm}^2/\text{m}^2$) and 69 males (54.8%; SMI $< 52.4 \text{ cm}^2/\text{m}^2$). BMD was $163.2 \pm 38.3 \text{ mg}/\text{cm}^3$ in females and $164.1 \pm 35.4 \text{ mg}/\text{cm}^3$ in males, with 75 females (35.7%) and 37 males (29.4%) having BMD $< 145 \text{ mg}/\text{cm}^3$ indicating osteopenia/osteoporosis. Similar prevalence of osteosarcopenia was seen between males (n=28, 22.2%) and females (n=44, 21.0%), and the incidence of low SMI and BMD increased with age in females and males. While average ISS scores were relatively similar (19.7 ± 9.6 in males and 18.6 ± 8.8 in females), the incidence rate of severe ISS scores (severe: >15 vs not severe: ≤ 15) varied more between sexes (64.3% vs 51.4% in males and females, respectively).

Individuals with a lower SMI spent significantly more days in the ICU and were more likely to have complications of infection during their hospital stay. However, individuals with a lower BMD were less likely to be placed on a ventilator and have gastrointestinal complications. SMI and BMD interactions were associated with the likelihood of being discharged to a rehabilitation facility. There were no significant associations between SMI, BMD, or SMI*BMD on MVC injury outcomes including ISS, MAIS, and fracture incidence. These findings have the potential to improve the management of MVC occupants that receive abdominal CT upon admission as muscle quantity (SMI) and BMD can both be derived and used for opportunistic screening and musculoskeletal health characterization.

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