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SUBJECT-SPECIFIC RISK ASSESSMENT OF OBESITY AND AGEING IN SPINE BIOMECHANICS

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Summary: As escalating health care concerns in western societies, obesity and ageing are recognized as risk factors of back pain. Although biomechanical factors (overloading and instability) directly influence the risk of back injuries and pain, little is yet known about the biomechanical risks associated with the obesity and ageing. We aim to investigate the effects of obesity and ageing on spine biomechanics in forward flexion by using a subject-specific trunk musculoskeletal finite element model. Age and obesity related changes in the muscle architecture, posture, segmental masses (head, arms and trunk), passive properties of the ligamentous spine, trunk kinematics and bone mineral density are considered. Using National Health and Nutrition Examination Survey (NHANES) dataset, two random sample groups (with the same size at each age cohort) including 1000 individuals from the general population and 1000 individuals with osteoporosis/osteopenia (T-score <-1) were selected and analyzed. To further investigate the effect of obesity and obesity shapes, we reconstructed and analyzed apple and pear body shapes corresponding to maximum and minimum waist circumferences. Age, body weight, waist circumference, body height and sex significantly ($p<0.01$) affected spinal loads. The 50th percentile spinal loads substantially increased due to ageing in females (flexion<500; L5-S1 compression of 613 N at 21 years vs 785 N at 69 years) and males (flexion<300; L5-S1 compression of 810 N at 22 years vs 979 N at 70 years).Though individuals with osteoporosis/osteopenia and females had smaller spinal loads in comparison with males, higher risk of vertebral compression fracture (i.e. compression over areal bone mineral density) was found in those with osteoporosis/osteopenia followed by females beyond ~50 years particularly at the uppermost lumbar levers. In obese individuals, at identical body weight and height, greater waist circumference (min vs max) substantially increased spinal loads at lower lumbar levels (as a ~20 kg additional body weight) and the risk of vertebral fracture due to larger spinal loads as well as smaller bone mineral density. In summary, this study quantifies the significant effects of obesity and its associated body shape as well as ageing in spine biomechanics and spinal loads.
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