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The effects of lifting speed on the peak external forward bending, lateral bending, and twisting spine moments

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Lifting tasks that involve twisting have been repeatedly implicated as contributing to the onset of occupational back injuries in epidemiological studies. The objective of this work was to quantify the three directional external moments acting on the spine during a sagittally symmetric and two asymmetric lifting tasks. A total of 15 subjects participated in the three lifting tasks. All tasks were performed at two qualitatively defined lifting speeds, 'slow' and 'fast', and with two load magnitudes: 10 and 20% of the subject's body weight. The mid-sagittal plane lifts were performed using two horizontal reach distances: 40 and 60 cm. A four-camera, two-forceplate motion and force measurement system were used to obtain the kinematic and kinetic data as the lifts were performed. A dynamic link-segment biomechanical model was used to quantify the reaction forces and moments at the ankle, knee, and hip and L5/S1 joints. Results from all tasks showed increased sagittal plane (forward bending) spine moments with the heavier load and at the faster lifting speed ($p<0.001$). Spine lateral bending and twisting moments increased during the mid-sagittal plane lifts with the greater reach distance and the faster lifting speed, respectively. The twisting moments on the spine were greatest as subjects lifted from in front and placed the load to the side but were dependent upon the lifting speed and the load magnitude. The lateral bending moments increased during this same task with the heavier load. However, the spine lateral bending moments were greatest when lifting from one side to the other.