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The Effect of Backpacks on the Lumbar Spine in Children: A Standing Magnetic Resonance Imaging Study

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Abstract

Study Design. This study is a repeated measures design to measure the lumbar spine response to typical school backpack loads in healthy children. The lumbar spine in this setting was measured for the first time by an upright magnetic resonance imaging (MRI) scanner.

Objective. The purpose of this study is to measure the lumbar spine response to typical school backpack loads in healthy children. We hypothesize that backpack loads significantly increase disc compression and lumbar curvature.

Summary of Background Data. Children commonly carry school backpacks of 10% to 22% bodyweight. Despite growing concern among parents about safety, there are no imaging studies which describe the effect of backpack loads on the spine in children.

Methods. Three boys and 5 girls, age 11 ± 2 years (mean ± SD) underwent T2 weighted sagittal and coronal MRI scans of the lumbar spine while standing. Scans were repeated with 4, 8, and 12 kg backpack loads, which represented approximately 10%, 20%, and 30% body weight for our sample. Main outcome measures were disc compression, defined as post-minus preloading disc height, and lumbar asymmetry, defined as the coronal Cobb angle between the superior endplates of S1 and L1.

Results. Increasing backpack loads significantly compressed lumbar disc heights measured in the midline sagittal plane ($P < 0.05$, repeated-measures analysis of variance [ANOVA]). Lumbar asymmetry was: 2.23° ± 1.07° standing, 5.46° ± 2.50° with 4 kg, 9.18° ± 2.25° with 8 kg, and 5.68° ± 1.76° with 12 kg (mean ± SE). Backpack loads significantly increased lumbar asymmetry ($P < 0.03$, one-way ANOVA). Four of the 8 subjects had Cobb angles greater than 10° during 8-kg backpack loads. Using a visual-analogue scale to rate their pain (0-no pain, 10-worst pain imaginable), subjects reported significant increases in back pain associated with backpack loads of 4, 8, and 12 kg ($P < 0.001$, 1-way ANOVA).

Conclusion. Backpack loads are responsible for a significant amount of back pain in children, which in part, may be due to changes in lumbar disc height or curvature. This is the first upright MRI study to document reduced disc height and greater lumbar asymmetry for common backpack loads in children.