The Effects of Backpack Use on Posture and Gait in School-Age Children – A Pilot Study

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Methodology

Phase 1 for N = 10
- 10 healthy students (5 girls, 5 boys) in 5th – 6th grades
- 5 tested twice to establish test-retest reliability for each condition
- Custom 4-marker set
- Head, shoulder & trunk posture and kinematics
- Lower extremity kinematics, kinetics, spatial-temporal parameters
- 6-camera Motion Analysis, 120 Hz HiRes system
- Level walking with 4 different backpack loads
  - > 0%, 10%, 15%, 20% of each subject’s body weight (BW)
  - Self-selected velocity and cadence
  - Random order of conditions
  - Backpack position standardized on each subject with both straps
- Other data:
  - Height
  - Leg lengths
  - Scoliosis screen
  - Frequency of back pain
  - Duration of back pain

Phase 2 for N = 227
- Height & weight for 3rd – 7th grade students at participating school
- Backpack loads on a single day for all 3 grades
- Backpack position standardized on each subject with both straps
- Random order of conditions
- Self-selected velocity and cadence
- 6-camera Motion Analysis 120 Hz HiRes system
- Custom 42-marker set
- 5 tested twice to establish test-retest reliability for each condition

Results

Static Load Effects

- Forward Head Posture
- Sagittal Trunk Posture - Hip Angle

Dynamic Load Effects

- Sagittal Trunk Kinematics
- Sagittal Hip Kinematics
- Sagittal Pelvis Kinematics
- Sagittal Knee Kinematics
- Sagittal Ankle Kinematics

Discussion

Forward head posture and sagittal trunk alignment in standing, as well as anterior trunk lean kinematics, were the only variables significantly affected by increasing backpack loads. Significant increases in anterior pelvic tilt kinematics as well as hip extensor moments were anticipated, but not found. Consequently, we suspect increased muscular effort and stress within the cervical, thoracic and lumbar spine due to the anterior orientation of the trunk relative to the pelvis with heavy backpack loads. However, to evaluate this hypothesis, biomechanical modeling of spinal structures extending from the occiput to the sacrum may be necessary to discern the relationships between backpack loads and adolescent back/neck pain.

Use of percentage body weight as the sole guideline for safe backpack loads does not take into account different body types, nor fitness levels. And, the fact remains that children and adolescents will continue to carry the books necessary for their particular grade level. Thus, thinner children may be at a greater risk than their heavier peers, since the lighter children will tend to carry proportionally heavier loads. Furthermore, present guidelines indicate that greater loads may be safely carried by heavier children, who may in fact, be less physically fit. The ‘bigger picture’ of the links between increasingly sedentary lifestyles in adolescents with decreased fitness levels, adolescent back/neck pain, and backpack loads may warrant investigation.

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