EFFECTS OF LOAD CARRIAGE ON LOWER EXTREMITY JOINT AND TRUNK MOVEMENT PATTERNS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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INTRODUCTION
Autism Spectrum Disorder (ASD) is characterized by highly variegated stereotype behavior and deficits in social interactions [1]. There is also evidence of significant motor deficits in gait in comparison to children with typical development [2,3]. This may place children with ASD at a motor functional disadvantage when carrying a loaded backpack during over-ground walking [4], which may increase their risks of sustaining an acute injury (trips, slips, and falls). A child’s school is a dynamic environment and may challenge children with ASD to process information about their surroundings more quickly. A child with ASD may not be able to process this information and it is therefore important to obtain more insight into the mechanical adaptations made during over-ground walking when carrying the load of a school backpack [2].

A common lower extremity adaptation in runners without ASD perturbed by an external load is increasing knee joint angle which can provide greater bandwidth for kinematic error while decreasing performance given an associated metabolic cost [5]. There is a gap in the literature as to how lower extremity joint angles in children with ASD adapt to a perturbation on gait, in this case load carriage. Therefore, the purpose of this study was to quantify bilateral symmetry changes in lower extremity joint angles (hip, knee, and ankle) during over-ground walking in children with ASD due load carriage. It was hypothesized that perturbations with backpack load would significantly alter the bilateral lower extremity joint symmetry during walking in children with ASD.

METHODS
10 children with a clinical diagnosis of ASD participated in the study (12.6±3.6 yrs old; 1.56±0.20m; 62.51±24.38 kg). Participants were asked to complete 15 walking trials under 3 different experimental conditions for a total of 45 walking trials, at a self-selected velocity. The conditions were: 1) over-ground walking with an empty backpack; 2) over-ground walking with 7.5% body mass added to a backpack; and 3) over-ground walking with 15% body mass added to a backpack. Three-dimensional lower extremity kinematics were obtained during walking using a 10-camera motion capture system. (200 Hz; Vicon Motion Systems Ltd. Oxford). The reflective marker model consisted of rigid cluster sets at the thighs and lower legs, and single markers at the ankles, knees, and foot. Data were normalized to 100% (101 data points) of the gait cycle. Bilateral sagittal plane hip, knee, and ankle joint angles were analyzed. Statistical analyses were performed on all 101 points of each kinematic parameter using a symmetry analysis [5] on a point-by-point basis. This was paired with a Model Statistic procedure (α = 0.05).

RESULTS AND DISCUSSION
Analysis revealed that children with ASD exhibited greater asymmetry at the hip joint during over-ground walking while carrying a weighted backpack (Table 1). However, the 7.5% weighed backpack demonstrated the greatest number of statistically significant asymmetries at the hip, knee and ankle. The 15% weighted backpack produced the most symmetrical movement pattern about the ankle. An overall average of significant differences across all joints was obtained for each of the 3 conditions. These results indicate greatest overall number of significant differences with a 7.5% weighted backpack. The 15% weighted condition led to the second greatest number of significant differences while no backpack weight led to the least number of significant differences in asymmetry.

Table 1. Percentages of Significant Differences Among Conditions

<table>
<thead>
<tr>
<th>Load</th>
<th>Hip</th>
<th>Knee</th>
<th>Ankle</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% BM</td>
<td>80.3</td>
<td>65.0</td>
<td>67.5</td>
<td>70.9</td>
</tr>
<tr>
<td>7.5% BM</td>
<td>91.4</td>
<td>78.9</td>
<td>72.5</td>
<td>80.9</td>
</tr>
<tr>
<td>15% BM</td>
<td>89.3</td>
<td>70.8</td>
<td>66.1</td>
<td>75.4</td>
</tr>
</tbody>
</table>

Although it is known that asymmetry exists in children with ASD [3], these data suggest that different masses of loads carried do increase symmetrical gait at the hip and knee joints. The increased symmetry in the ankle joints reveals a positive influence of backpack loads at 15% although increased mechanical deviations may have been present at the upper extremities. This further suggests the need to determine appropriate guidelines and interventions for children with ASD relative to load carriage.

CONCLUSIONS
Many school-aged children are faced with increasing backpack loads as they progress in their education and it is therefore important to examine the effects of backpack load carriage during gait in children with ASD. The current study revealed that a 7.5% body weight backpack is the least optimal for producing lower extremity joint symmetry when compared to a 15% or 0% weighted backpack. Therefore, it is important for the parent or clinician to make careful considerations for the backpack load of a child with ASD. In this study, only lower extremity kinematics were analyzed. Further research is needed to examine upper extremity effects.

REFERENCES