POSTURAL CHANGES IN YOUNG ADULTS WHEN WEARING A TRADITIONAL BACKPACK VERSUS THE BACKTPACK

Kimberly D. Dahl, Henry Wang, and D. Clark Dickin

Ball State University, Muncie, IN, USA
email: biomech@bsu.edu

INTRODUCTION

Load carriage can be the most convenient way to transport items from point A to point B. Over 40 million students in the United States use backpacks on a regular basis [1]. Poor posture brought on by improper backpack use has led to alignment issues such as forward head posture, rounded shoulders, kyphosis, low back pain, and an asymmetrical axial skeleton during both standing and gait. In 2013 alone, over 28,000 backpack-related injuries were treated at medical practices [2].

The principal purpose of this study was to assess head and trunk position during static stance before and after walking between a traditional backpack and a nontraditional backpack designed to disperse the load across the body and close to the vertical axis. It was hypothesized that the nontraditional backpack would result in a more upright posture showing less forward trunk inclination and forward head posture than the traditional backpack.

METHODS

Following IRB approval, twenty-four healthy young adults (22.5±2.5 years, 12 male) participated in this study. Participants were free from injury and any other condition that would prevent them from carrying 15% and 25% of their body weight in a backpack. Participants also had a history of using a traditional backpack (3+ days/week). An informed consent and a health demographic questionnaire were completed prior to participating.

A 14-camera Vicon infrared motion capture system (VICON Inc., Denver, CO, USA) collecting at 120 Hz and an AMTI force plate instrumented treadmill (AMTI Inc., Watertown, MA, USA) collecting at 2400 Hz were used in conjunction with a modified Plug-In Gait marker set that included marker clusters on the thigh and shank of each leg. A traditional backpack (BP) and the BackTpack (BTP) (BackTpack LLC, Salem, OR, USA) were used for load carriage. Load was added to the backpacks to equal 15% and 25% of the wearer's body weight and was evenly distributed in the backpacks, placing the heaviest weight closest to the spine for the traditional backpack and balancing the weights between the two pockets for the BackTpack. Each participant was assessed under five conditions: static recordings with no backpack and each of the two backpacks at the two load percentages both before and after walking for 6 minutes at a speed of 1.4m/s. The order in which the backpacks were worn and the load was applied was randomized, although the no backpack condition always came first.

Head angle and trunk angle in the sagittal plane were assessed using Visual 3D software (Version 5.0, C-Motion, Germantown, MD, USA) and pre to post-walk data was analyzed using two one-way RM ANOVAs to compare the load percentages back to the No Load condition. A two-way RM ANOVA was used to compare the backpack and load conditions to each other. Where appropriate, Bonferroni corrections were utilized. Analyses were conducted in SPSS (Version 22 for Windows, SPSS Inc., Chicago, IL, USA) and the alpha level was set at $p<.05$.

RESULTS AND DISCUSSION

For all individual pack conditions (No Load, BTP, and BP) at both load conditions (15% and 25%), there was a significant difference in head angle between pre- and post-walk ($p=.004$, $p=.014$). Both backpacks at 15% and 25% were significantly

different from each other (p=.002, p<.001) and from the no load condition (p<.001).

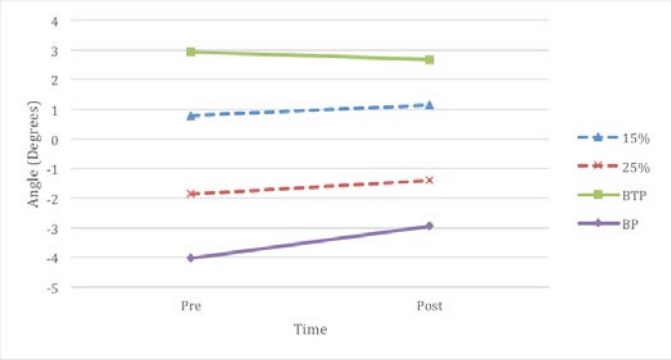

Figure 1: Trunk angle comparison in degrees for interaction effects between time (pre- to post-walk) and load percentage (dashed lines) and backpack type (solid lines). Abbreviations: BTP, BackTpack; BP, traditional backpack.

In comparing the two backpacks during both load percentages to each other, no significant differences were seen between time, load, or pack type for head or trunk angle. However, significant differences were seen in the time x pack interaction (p=.030) and in the pack x load interaction (p=.008) for trunk angle. These results can be seen in Figure 1.

Head angle was more negative (less hyperextension at the neck) and trunk angle was more positive (less forward flexion) for the BTP than the BP for both the 15% and 25% loads (Table 1), however following the walking period the BP exhibited a slight reduction in trunk flexion while the BTP resulted in a slight increase in flexion. Overall, the more upright posture seen with the BTP may be due to the load placement along the vertical axis in conjunction with the line of gravity rather than being placed behind the wearer as with the BP. The findings supported the hypothesis, which was that the nontraditional backpack would result in a more upright posture than the traditional backpack.

CONCLUSIONS

In conclusion, the BTP more closely resembled the participants' natural stance as determined by the No Load condition for both head and trunk angle. The more upright posture supported by the BTP may help reduce characteristics of poor posture such as forward head positioning and forward trunk lean.

REFERENCES

1. Wang Y, et al. *Ergonomics* **44**, 858-869, 2001.
2. Ip K, et al. *American Academy of Orthopaedic Surgeons*, 2014.

ACKNOWLEDGEMENTS

Thank you to BackTpack for donating the nontraditional backpacks to help support this study.

Table 1: Mean (SD) joint angles of head and trunk in the sagittal plane for all five trials pre- and post-walking. Abbreviations: BTP, BackTpack; BP, traditional backpack.

Joint Angle (deg)		**Trial Condition**				
		No Load	**BTP 15%**	**BTP 25%**	**BP 15%**	**BP 25%**
Head	**Pre**	-30.88(8.36)	-24.20(9.27)	-21.79(9.10)	-19.62(10.13)	-16.40(9.49)
	Post	-29.48(8.85)	-21.60(8.00)	-20.19(8.92)	-17.92(9.46)	-14.60(9.42)
Trunk	**Pre**	7.43(2.63)	3.69(2.86)	2.19(2.68)	-2.13(4.09)	-5.89(4.76)
	Post	7.95(2.63)	3.26(2.83)	2.07(2.74)	-0.97(3.04)	-4.85(3.09)