

Gait Compensation for Instability Caused by Backpacks

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Introduction: Backpacks are a common sight in western North Carolina. Whether on college students trekking to class, or hikers on the Appalachian Trail, they are an essential part of life in this area and many others. The real question is, are they safe? There have been a number of studies investigating how backpacks affect the spine and shoulders, but few into how backpacks affect gait. Temporal spatial gait parameters are often used to assess a person's stability. People exhibiting low stability, are at risk for fall or injury. The main objective of this study is to determine if there are temporal spatial differences between walking with and without a backpack.

Methods: For our study we measured temporal spatial gait parameters using a 20 foot GAITRite Mat. Twenty-four participants (12 males and 12 females) between the ages of 18-39 were enrolled in the study. Each participant signed an inform consent form approved by the IRB prior to beginning the study. Participants were instructed to walk barefoot back and forth across the mat under two conditions: Unloaded, and wearing 20% of their body weight in a pack on their back. Data for the left and right legs were averaged – excluding foot progression angle.

Results: The step length, step width, double limb support percentage, and foot progression angle were compared using unloaded as a baseline (Table 1). The step length decrease from 64.3 cm to 63.3 cm. This decrease of 1.0 cm was significant ($p=0.031$). Step width increased by 0.95 cm ($p=0.011$) and double limb support increase by 3.0% ($p=0.000$), both also significant. Foot progression angle decreased on both the right and left side, but the difference was only statistically significant on the right side.

Table 1: Results of Gait Analysis

	Unloaded Mean (SD)	Loaded Mean (SD)	Difference	P
Step Length (cm)	64.3 (6.3)	63.3 (6.8)	-1.0	0.031*
Step Width (cm)	9.4 (3.3)	10.4 (3.9)	1.0	0.011*
Double Limb Support %	22.2 (2.2)	25.2 (2.3)	3.0	0.000*
Foot Progression Angle - Left	2.2 (5.9)	1.7 (5.5)	-0.5	0.198
Foot Progression Angle - Right	4.7 (4.0)	3.8 (4.2)	-0.9	0.022*

* Indicates significance

Discussion: The results show that backpacks significantly affect a wearer's gait. Participants increased step width and double limb support, and decreased step length. These are all measures taken to increase stability (Hak, 2013). Therefore we concluded that backpack carriage caused instability and the wearer compensated by altering their gait to a more stable pattern. Conflicting data on foot progression angle may be attributed to a small sample size or the initial variability of the subjects. A larger percentage of subjects had a negative foot progression angle on the left verses the right.

Reference: Hak L, Houdijk H, Steenbrink F, Mert A, van der Wurff P, Beek PJ, Dieen JH. Stepping strategies for regulating gait adaptability and stability. *J Biomech.* 46(5):905-911, 2013