THE EFFECTS OF EXTERNAL WEIGHT CARRIAGE ON POSTURAL STABILITY

[1]Michelle Heller, [2]John Challis, and [2]Neil Sharkey
[1]Mechanical and Nuclear Engineering, and [2]Kinesiology, The Pennsylvania State University, University Park, PA, USA
email: nas9@psu.edu, web: www.biomechanics.psu.edu

INTRODUCTION

Postural stability has been defined as "the ability to return the body close to the equilibrium point when exposed to a perturbation" [1]. Karlsson and Frykberg suggested that two different mechanisms keep an individual in a stable position: the load-unload strategy and the ankle strategy [1]. Medial-lateral stability is maintained through the load-unload strategy when a person shifts his/her weight from one foot to the other. The ankle strategy is used to maintain anterior-posterior stability by employing the muscles crossing the ankle joint to create a moment to resist loss of balance and is the mechanism of greatest interest when investigating the effect of load distribution on postural stability. Both load carriage and associated muscle fatigue have the potential to decrease a person's postural stability. Compensatory mechanisms such as increased trunk inclination during load carriage serve to keep the center of mass over the feet, and the degree of flexion is dependent on the magnitude of the external load. This observation illustrates that there may be a correlation between load carriage and stability; such information could be valuable in combating common injuries encountered by military personnel.

Kinematic changes of load carriage include a greater degree of knee flexion after heel strike [2], decreased transverse pelvic and thoracic rotation, decreased phase shift between pelvic and thoracic rotation, increased hip excursion [3], and increased musculoskeletal stiffness [4]. The changes in gait kinematics are partially a result of energy-saving mechanisms, but may also function to help increase dynamic postural stability. Static postural control studies may begin to unravel some of these relationships.

METHODS

Twenty-two female subjects (mean: 20.8 years, S.D.: 1.7 years) with no history of musculoskeletal disorders volunteered to participate in the study. Each subject was asked to stand upright on a Kistler force platform under each of three conditions: one foot quiet standing, two feet quiet standing, and while wearing an 18.1 kg military pack. The subjects were asked to concentrate on an "X" located 1.5 meters from the ground. Data were collected at 1000 Hz in conjunction with a Motion Analysis system. One thirty-second trial was collected for each condition, as LeClair et al. [5] determined this was sufficient to see differences between conditions.

The standing trials involved standing quietly on two feet and the one-foot trials involved standing while one first metatarsal head was placed against the opposite medial malleolus. During the external load condition, the subjects were asked to wear a standard issue military pack, which was obtained from the Penn State ROTC program.

RESULTS AND DISCUSSION

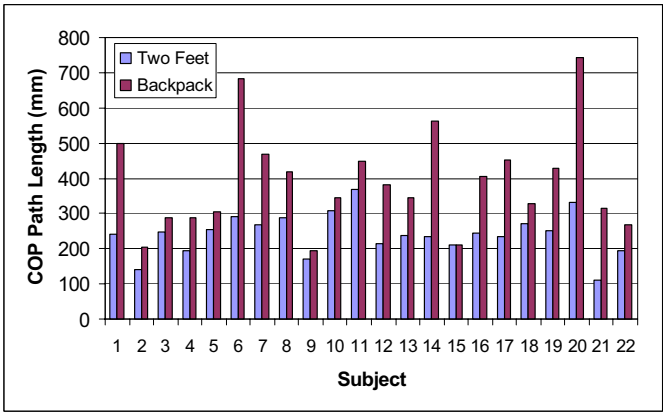

Figure 1: The center of pressure path lengths for each of the subjects indicates more sway under the backpack condition than during quiet standing.

Standard measures of postural stability indicated that the subjects were less stable while carrying the military pack. The data were analyzed using a paired t-test. The center of pressure (COP) path lengths were higher under the load carriage condition than the two foot quiet standing ($P < 0.001$), as shown in Figure 1. The area of the ellipse that included 85% of the data points was calculated for each trial. The COP areas were higher for the load carriage condition ($P < 0.001$). Both of these results indicate more postural sway when carrying an external load. Furthermore, the anteroposterior (AP) and mediolateral (ML) excursions were both greater under the load carriage condition, with $P = 0.019$ and $P < 0.001$ respectively. All standard measures of postural stability indicate a decrease in stability when the subjects donned the military pack.

CONCLUSIONS

Wearing an external load of 18.1 kg, which is less than the minimum load carried by military personnel, reduces postural stability in healthy, young females. This could translate into a higher likelihood of injuries such as ankle sprains in this population.

REFERENCES

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