PEAK GROUND REACTION FORCES AND BRAKING FORCES WHILE WALKING DOWNHILL WITH AND WITHOUT THE USE OF TREKKING POLES

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Introduction

As a recreational pursuit, hiking has become a popular pastime in America, as well as in many parts of the world, especially where mountains are a predominant part of the geographic area. In addition, many outdoor-based occupations require downhill walking as a component of the job. The purpose of this research project was to examine peak GRFs and peak braking forces (BF) of walking downhill at different gradients while hiking with or without trekking poles. Gradients included level ground, 15, 20 and 25 degrees, which are similar to common grades of mountain trails. Gender differences were also examined.

Manufacturers of trekking poles claim that using poles reduces forces on the body by as much as 21% (Sierra Trading Post Catalog, 1999). Schwameder et al. (1999) examined walking downhill, with and without the use of trekking poles, at a gradient of 25 degrees, and found a reduction in ground reaction forces with the use of the trekking poles. Knight and Caldwell (2000) examined the use of trekking poles while walking uphill at a five degree grade and concluded that pole use redistributed some of the load from backpacks, thus alleviating stress from the lower extremities. Willson et al (2001) examined the effects of walking poles on lower extremity gait mechanics for level walking only. Differences were noted for walking speed, vertical ground reaction forces, vertical knee joint reaction forces, and the knee support moment, depending on the poling condition used. Lastly, Abendroth-Smith and Bohne (in press) noted changes in gait patterns and ground reaction forces while hiking downhill (without pole use) as the angle of incline increased, with observed differences between men and women in their walking strategies on differing slopes. As women usually have a lower center of gravity and specific structural differences, hiking downhill may impact women differently.

Methods

Ten subjects were recruited on a volunteer basis, from a healthy, active adult population (5 men, 5 women). Participants were screened for any conflicting medical issues and signed informed consents. Procedures included a practice session which involved walking down a wooden ramp at all gradients to become familiar with each appropriate protocol, until participants felt natural in their gait patterns, and with pole use. The data collection consisted of 10 successful trials per condition. A predetermined counterbalanced order of conditions was used, due to the change-over time in adjusting the slope of the ramp. Force data was collected on a Bertec force plate at 500 Hz, mounted flush with the wooden ramp. Means and SD were calculated for the multiple trials of each condition. All force data was normalized to body mass (N/kg).

Results

Kinetic parameters of peak GRF and BF (N/kg) were examined for differences between gradient, gender and pole use. Significant differences between conditions were determined using a 3-way ANOVA. Statistically significant differences ($p<.05$) were noted for changes in GRFs between gradients, and for gender, but not for pole use (Figure 1). Peak GRFs were minimally less with pole use for level walking and at the 25 degree slope, which has been previously noted (Schwameder et al, 1999; Willson, et al, 2001). However, at the 15 and 20 degree slopes, pole use resulted in similar or higher GRFs than without pole use. Gender differences were similar in walking without poles to previous research (Abendroth & Bohne, in press) for women, but men demonstrated little or no decrease in peak GRFs at the higher slopes.

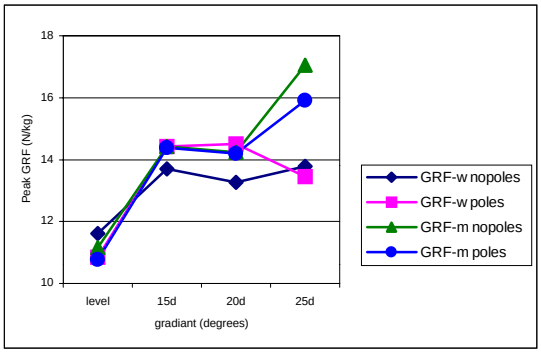

Figure 1. Peak GRF with and with pole use.

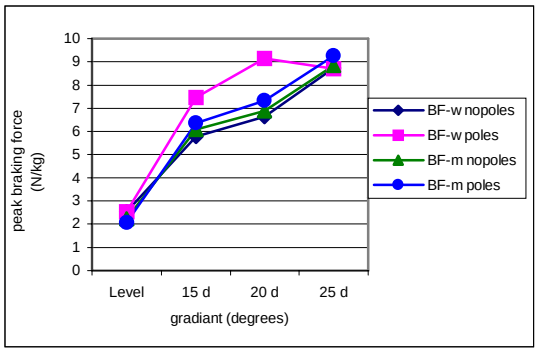

Figure 2. Peak BFs with and without pole use.

Statistically significant results for BFs were similar to GRF data, in that gradient and gender differences were noted overall, but with pole use, BFs were not statistically different (Figure 2). Again women demonstrated higher BFs with pole use than without at the middle gradients, while the men demonstrated similar BFs regardless of pole use.

Discussion and Conclusions

Pole use did not significantly reduce forces (GRF or BF) on the body at any of the measured gradients, even though previous research has documented differences. Of greater concern are the increased forces at the middle gradients, for women especially, with pole use. Though not statistically significant, these differences may indicate that either incorrect pole use can lead to greater forces acting on the body, or that pole use might hinder walking while hiking downhill at certain gradients. Differences were noted in normalized forces between men and women as well, indicating changes in walking strategies at the differing gradients. Recommendations include the examination of joint forces and moments with the use of poles at multiple gradients, and examination of medial/lateral forces to see if stability is enhanced with pole use. It is hoped these results might lead to useful information for both men and women in maintaining a healthy lifestyle, while providing gender specific recommendations for keeping individuals injury and pain free while hiking downhill.

References

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Sierra Trading Post Fall Catalog (1999).