THE EFFECTS OF HIKING POLES ON BALANCE AND VALGUS/VARUS KNEE ANGLES IN FEMALE HIKERS

Julianne Abendroth-Smith[1], Winthrop Head[1], and Michael Bohne[2]

[1]Willamette University, Salem OR; [2]Western Illinois University, Macomb, IL USA
Email: jabendro@willamette.edu

INTRODUCTION

Hiking has become an increasingly popular activity for recreation and enhancing physical fitness. Hiking pole use has increased in popularity during the past decade, partly in response to evidence that hiking poles can reduce lower extremity joint forces in both men and women (Schwameder, et al., 1999; Abendroth-Smith & Bohne, 2004). However, little is known about the more intricate aspects of hiking pole use, such as their effects on stability and frontal plane joint kinematics, particularly in women, who demonstrate a greater rate of injury while hiking (Blake & Ferguson, 1993).Yet in 2002, 29% of American women participated in hiking (Boulware, et al., 2004). The aim of this study was to examine possible relationships between static and dynamic measures of balance, frontal knee joint angles during stance, and the use of poles while hiking downhill, to prevent injury.

METHODS

Eight women (average age = 45, ht= 1.67 m wt = 64.3 kg), all experienced hikers, walked down a 20-degree ramp in two different conditions; with and without poles. All subjects signed informed consents and approval was obtained by the University IRB. Forces were measured via a Bertec force plate set into but separately from the ramp (1000 Hz). Peak ground reaction force (Fz), peak A/P force (Fy) and the SD of the M/L force (Fx) were examined, with Fz and Fy forces normalized to body mass (N/kg).

Self-selected speeds were maintained across conditions using an infrared timing system and all trials (ten per condition) were recorded with a digital video camera (60 Hz). Knee joint angles of one leg, during the stance phase on the force plate, were measured in the frontal plane via kinematic analysis (Datapac Software, Run Technologies). Data was filtered using a Butterworth low pass filter (7 Hz), and averaged together over the 10 trials. Three supports were examined (25%, 50% and 75% of stride) for knee valgus and varus angle differences.

Participants also completed five trials in three balance test conditions. Static balance tests included a one-legged quiet stance on the force plate for 4 second intervals, and then repeated while standing on a foam pad placed on the force plate. Dynamic balance was similarly obtained using a balance disk. All data was collected at 1000 Hz, and subsequent center of pressures (RMS) obtained via DataPac software. A final summative balance, with all three balance measures, was also used in correlations for possible relationships between changes in forces and knee angles due to pole use. Statistical significant was set at .05, and repeated measures ANOVAs were used for comparisons. Pearson coefficient (r) was used for the correlations. Effect sizes (ES) were also calculated.

RESULTS AND DISCUSSION

GRFs demonstrated little change between the pole conditions, while braking forces were slightly greater with pole use. Fx variability was less with pole use, indicating the poles may have been used more for stability than for decreasing forces (Figure 1). No statistical significant was noted for any of the comparisons. ES were <.21.

No differences were seen in knee valgus angles in the early stance, but knee varus angles were less with pole use, though not statistically (Figure 2). ES were .12, .35, and .66, respectively, for the three supports.

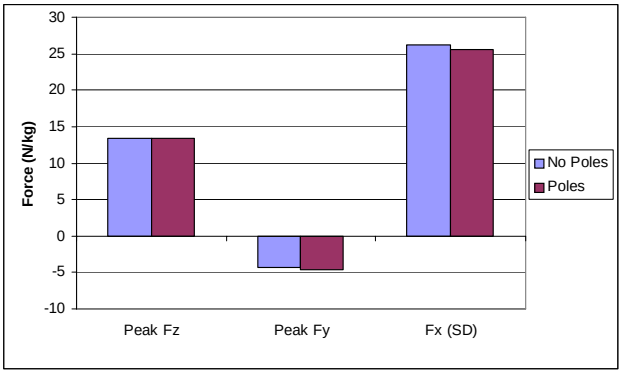

Figure 1. Change in forces with and without pole use.

Correlations between the balance tests and changes in force between pole conditions were moderate, with the highest correlation between Fz and quiet stance (r = .53). The change in Fx correlated best with foam balance (r = .46). Midstance changes in knee angles correlated moderately with changes in Fz (r = .44) and with balance overall (r = .70). All support knee joint angle changes correlated weakly with Fx (r = .26 to .31).

SUMMARY

While some indications of the aspects of pole use on the lower extremities were noted, the participants were a more homogenous group than expected. It may be this group of experienced women hikers were all relatively fit and comfortable enough with the hiking protocol on a 20 degree ramp, and so did not demonstrate much change in forces with pole use. A more heterogeneous group of hiking experience may reveal stronger relationships.

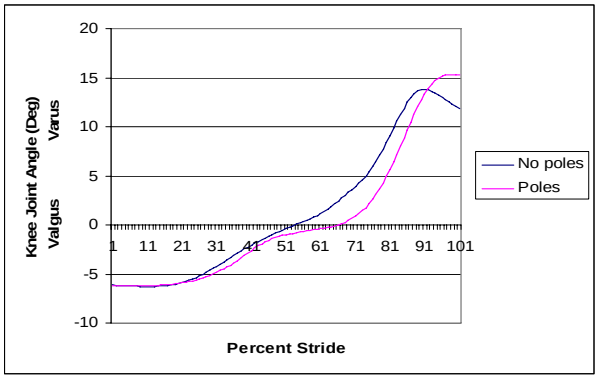

Figure 2. Average frontal plane knee joint angles over 100 % of stride.

There is some indication that good balance may be associated with the way women use the poles (stability vs. lessening forces). Finally, knee varus angles do appear to lessen slightly with pole use. This may indicate the supporting leg during stance is less likely to be subjected to certain traumatic injury, such as ankle and knee sprains, when poles are used for stability.

REFERENCES

Abendroth-Smith, J., & Bohne, M. (2002) *Proceedings of the Fourth World Congress of Biomechanics*, Calgary, Canada.

Blake, R. & Ferguson, H. (1993). *J of Amer Podiatry Assoc*. **83**(9). pp. 499-503.

Boulware, D., Forgey, W., & Martin, W. (2003) *The Amer J of Medicine*. **114**(4). pp. 288-293.

Schwameder, H., Roithner, R., Muller, E., Niessen, W., & Raschner, C. (1999). *Journal of Sport Sciences*, ***17***, 969-978.

ACKNOWLEDGEMENTS

The Authors wish to thank Willamette University's Science Collaborative Research Program (SCRP) for their generous support, and Lindsay Yocum who also worked on this project.