Preventing knee injury in downhill hiking

Megan Pitz and Eli Smith
Why is it Important?

- Increasing popularity as a recreational sport [2]
- Almost two million people hike sections of the Appalachian Trail every year [1]
- Great Smoky Mountains is the most visited national park with over 850 miles of hiking trails [6]
Biomechanics of Hiking

- Knee joint loads show the most increase during downhill hiking vs. level walking [4]
- During downhill walking knee joint loads can be up to 8x your body weight [3]
- Peak knee power absorption during downhill walking is close to that of running on a level surface [4]
- Knee proprioception has been shown to significantly decrease during downhill hiking due to fatigue [5]
- Higher joint loads increase chances of joint injury

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</thead>
<tbody>
<tr>
<td><strong>Trail Width</strong></td>
<td>72&quot; or more</td>
<td>36&quot; or more</td>
<td>24&quot; or more</td>
<td>12&quot; or more</td>
<td>6&quot; or more</td>
</tr>
<tr>
<td><strong>Tread Surface</strong></td>
<td>Hardened or surfaced (paved)</td>
<td>Firm and stable</td>
<td>Mostly stable with some variability</td>
<td>Widely variable</td>
<td>Widely variable and unpredictable</td>
</tr>
<tr>
<td><strong>Average Trail Grade</strong></td>
<td>Less than 5%</td>
<td>5% or less</td>
<td>10% or less</td>
<td>15% or less</td>
<td>20% or less</td>
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Common Injuries

- Soreness and pain in the knee are very common
- Can lead to osteoarthritis [7]
- Excessive knee joint stresses lead to ACL injuries [8]
- Important because ACL stabilizes knee joint movement

Why do we care about hiking injuries?

- Solo hikers who become injured on the trail can be stranded

Previous Research

- Plenty of literature on individual elements affecting knee joint forces:
  - Hiking poles
  - External loads
  - Hoverglide backpack
- Important because it can help companies, retailers, and rangers recommend how to best be prepared
Hiking Poles

- Nordic walking
  - Total body version of hiking that utilizes upper body muscles
- “Significant differences between downhill walking with and without hiking poles were observed for peak and average magnitudes of ground reaction force, knee joint moment, and tibiofemoral compressive and shear forces (12-25%)” (Schwameder et al)
External Loads

- Increased knee flexion occurs post heel contact while carrying heavy loads
- Increased loads showed greater peak GRF compared to unloaded walking
- Carrying loads leads to increased rates of fatigue which affects proprioception
Hoverglide Backpack

- Gliding backpack [9,10]
- Project originally created for military applications, designed to create electricity through Suspended Load Technology (SLT)
  - Two frames attached through elastic coupling
- Reduces loads by up to 86%
Hoverglide Backpack (con’t)
Proposed Research

- Gap in Research: No one has studied these elements together to determine their combined efficacy.
- Question: Does one specific gear combination minimize joint load/injury across downhill hiking conditions?
- Goal: Analyze joint loads and GRFs for gear combinations with various downhill hiking conditions.
- Hypothesis: Hiking poles and hoverglide backpack used in tandem will exhibit the largest decrease in joint loads and GRFs.
Testing Methods

- Treadmill with adjustable incline
- Force plates within treadmill to measure GRF
- Markers used to measure kinematics
- Have subjects test different weight loads on treadmill
- Conditions in testing matrix analyzed to determine combination of gear with minimum knee joint loads
- ANOVA to measure significance of each condition
# Testing Matrix

<table>
<thead>
<tr>
<th>Slope</th>
<th>None</th>
<th>Hiking Poles</th>
<th>Hoverglide Backpack</th>
<th>Hiking Poles and Hoverglide Backpack</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 degree slope</td>
<td>10% BW load</td>
<td></td>
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<td></td>
<td>20% BW load</td>
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<tr>
<td></td>
<td>30% BW load</td>
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<tr>
<td>8 degree slope</td>
<td>10% BW load</td>
<td></td>
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<td>20% BW load</td>
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<td>30% BW load</td>
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<tr>
<td>12 degree slope</td>
<td>10% BW load</td>
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<td>20% BW load</td>
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Conclusions

- To immediately reduce hiker unpreparedness, hike ratings should be displayed on trail signs.
- After completion of our proposed study, the following will be determined:
  - Recommended gear for different trail ratings
  - Maximum recommended weight for trail ratings
  - Better hiker preparedness
- Reducing hiker injuries will:
  - Prevent hikers from becoming stranded
  - Reduce National Park resources spent on search and rescue
  - Allow people of all ages and physical abilities to enjoy hiking
References

[10] http://science.sciencemag.org/content/309/5741/1725
Questions?