THE EFFECT OF RUNNING SPEED ON PEAK PLANTAR PRESSURE

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INTRODUCTION
Running is a very popular activity for recreational and competitive athletes. Unfortunately, just like other physical activity, repetitive impacts from a series of collisions with the ground during running might cause overuse injuries in lower extremity. Plantar pressure measurement systems are not only capable of measuring pressures at the interface between the shoe and the foot, but also allow calculation of the maximal vertical ground reaction force (VGRF). Therefore, the purpose of this study was to measure and to clarify the relationship between insole peak PP and running speed during treadmill ambulation at five different foot regions in young adults.

MATERIALS AND METHODS

Subjects
Eight active subjects (three males and five females, mean age 19.9±0.6 years, mean body weight 61.0±8.21 kg) wore standardized shoes without any known foot pathologies, history of lower limb complaints of either orthopedic or neurological origin, or pain associated with gait volunteered participate in the study after being fully informed about the aims and procedures.

Instrumentation
A Medilogic in-sole foot measuring system (T&T medilogic Medizintechnik Gmbh, Mittelstr, Germany) (Figure 1) measured pressures on the plantar surface of the foot during walking and running on various speeds, and plantar pressure signals were sampled at 60Hz.

Procedure
Each subject ran on treadmill in seven different speeds (3, 4, 5, 6, 7, 8 and 9 mile/hour). Investigators selected all intact footprints from each trail to analyze. Afterward each footprint was divided into five different regions (masks): hallux / great toe (T), medial forefoot (M), central forefoot (C), lateral forefoot (L) and heel (H) (Figure 3). The maximum pressure evaluation (MAX) and average evaluation (AVG) were measured in each region and averaged over the 30 seconds. Maximum pressure evaluation (MAX) represented the maximum value of each sensor’s reading at any time during the data collection period. Average evaluation (AVG) represented the average values of each sensor’s reading at any time during the data collection period.

RESULTS
The results are shown in Table 1. Running speed affected PPP differently at the five examined plantar regions. The T and H had the highest PPP, which increased with faster speeds. However, the PPP in MF, CF and LF initially increased, but then plateaued or even decreased at the fastest speeds.

Table 1: Average Peak Plantar Pressure

<table>
<thead>
<tr>
<th>Speed/region</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>27.9±15.1*</td>
<td>34.1±14.1†</td>
<td>35.2±14.7*</td>
<td>40.0±16.1†</td>
<td>43.7±15.1‡</td>
<td>45.5±6.6*</td>
<td>47.0±6.5‡</td>
</tr>
<tr>
<td>M</td>
<td>10.0±7.2</td>
<td>10.2±5.4</td>
<td>16.4±13</td>
<td>17.9±14.7</td>
<td>19.1±3.6</td>
<td>18.8±4.3</td>
<td>17.6±4.2</td>
</tr>
<tr>
<td>C</td>
<td>13.7±4.5</td>
<td>13.0±3.0</td>
<td>17.3±2.5</td>
<td>19.5±3.9</td>
<td>20.9±2.9</td>
<td>19.8±2.7</td>
<td>20.1±1.9</td>
</tr>
<tr>
<td>L</td>
<td>15.8±5.5</td>
<td>13.9±5.1</td>
<td>16.1±2.9</td>
<td>18.5±3.3</td>
<td>17.5±3.5</td>
<td>17.0±4.0</td>
<td>17.9±3.3</td>
</tr>
<tr>
<td>H</td>
<td>23.8±6.8*</td>
<td>26.8±6.6‡</td>
<td>27.2±6.1*</td>
<td>28.5±5.9†</td>
<td>30.0±3.5†</td>
<td>31.3±4.0*</td>
<td>33.3±3.3*</td>
</tr>
</tbody>
</table>

*: p < .05, T to M, C, L.; †: p < .05, H to T, M, C, L.; ‡: p < .05, T to H, M, C, L.

DISCUSSION
The results of this study demonstrated that specific regions of the foot responded differently to changes in walking/running speed. At the hallux and heel, peak plantar pressure increased linearly as gait speed increased. However, increasing walking/running speed had less of an effect at the central, medial, and lateral forefoot. The central, medial, and lateral forefoot peak plantar pressures initially increased at the slower walking/running speeds but then remained constant or decreased at the faster speeds. The decrease in forefoot peak pressure at faster walking speeds may be explained by contact time duration. In addition to discrepancies in data processing, protocol variations such as treadmill and over-ground walking have been shown to affect gait characteristics and may affect plantar pressure measurements. Running/walking speed affected peak plantar pressure measurements at different plantar regions and should be monitored during data collection.

CONCLUSION
This study demonstrated that the effect of running speed on PPP varied with different plantar regions. The highest PPP were located in the T and H regions. The data elucidated the relationship between PPP and running speed, which can also be used as a reference data for future research, especially in exercise intervention for at-risk population who should avoid excessive plantar pressure.

REFERENCES