LOWER-EXTREMIT Y STRENGTH, POWER AND KNEE LOADING IN YOUNG WOMEN

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INTRODUCTION
The peak knee adduction moment (PKAM) is a gait measure which best represents the mechanical pathology associated with knee osteoarthritis (OA). Recent research has focused on whether the PKAM is modified by muscle function. While knee strengthening exercises reduce pain and improve quality of life, strengthening has little effect on the PKAM in OA [1]. Lower-limb muscle power is more useful than strength in explaining physical performance in healthy aging [2]. The purpose of this study was to compare the effects of knee strength and power on the adduction moment during gait.

METHODS
We studied the right knees of 25 active, healthy women (23.5 ± 3.6 years, Body Mass Index: 23.7 ± 3.2 kg/m²). Gait analysis was conducted with an 8 camera passive motion capture system, sampling at 100 Hz (MX40, Oxford Metrics, Oxford, UK). Twenty-four reflective markers were affixed to landmarks based on the Plug-in Gait Lower Extremity Model (Vicon Nexus, Oxford Metrics, Oxford, UK). Motion capture was synchronized with three force platforms sampling at 1000 Hz (AMTI, Watertown, MA, USA). Participants ambulated at self-selected speeds. Data was exported to Visual3D (C-Motion, Inc., Germantown, MD, USA) for analysis. External joint moments were normalized to body mass and time normalized to the gait cycle. The mean of 5 gait trials was calculated for each participant. Joint moment data were ensemble averaged across all participants to provide a representative curve (Figure 1). The first and second peaks from the KAM waveforms were extracted for each participant.

Peak knee extensor and flexor torque (Nm) during a maximum voluntary isometric contraction (MVIC) with the knee extended to 60° was recorded on a dynamometer (Biodex Medical Systems, Shirley, NY, USA). Peak torques were normalized to body mass [3] and represented by a single mean value from 5 consecutive isometric cycles. Peak knee extensor and flexor power (Nm-Deg/sec) was calculated by multiplying torque (Nm) by angular velocity (Deg/sec) during repetitive isometric dynamic knee contractions. Resistance was set at 50% MVIC for both knee extension and flexion. Peak powers were normalized to body mass and represented by a single mean value over 5 consecutive isometric cycles (Table 1).

Correlations were used to examine the relationships between the first PKAM and peak torque and power separately. Linear regressions analyzed these relationships while controlling for gait speed. This analysis was repeated for the second PKAM.

RESULTS
Peak extension torque was significantly correlated with both the first and second PKAM (r=0.53, p=0.01 and r=0.40, p=0.05, respectively). Regression showed that 29.6% of the variance in the first PKAM was significantly explained by peak extension and flexion torque (p=0.03), after controlling for gait speed. The variance in second PKAM was not significantly explained by peak torques. Peak powers were neither correlated with PKAM, nor did they explain a significant portion of the variance in the data.

DISCUSSION & CONCLUSIONS
In young, healthy women, peak knee extension torque explains a significant portion of the variability in the first PKAM. These relationships have not been investigated in samples with knee OA. It is possible that absolute strength has a greater effect on gait mechanics in healthy young adults compared to an OA population. Although PKAM is correlated with extension torque, it is not related to the rate at which this torque is generated.

REFERENCES

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Table 1: Mean (standard deviation) of gait, torque, and power measures.

<table>
<thead>
<tr>
<th></th>
<th>1st PKAM</th>
<th>2nd PKAM</th>
<th>Gait Speed (m/s)</th>
<th>Peak extensor torque (Nm/kg)</th>
<th>Peak flexor torque (Nm/kg)</th>
<th>Peak extensor power (Watts/kg)</th>
<th>Peak flexor power (Watts/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>0.37 (0.11)</td>
<td>0.20 (0.12)</td>
<td>1.25 (0.16)</td>
<td>2.72 (0.45)</td>
<td>1.29 (0.22)</td>
<td>229.84 (67.16)</td>
<td>142.19 (48.54)</td>
</tr>
</tbody>
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Figure 1: Average knee adduction moment over gait cycle (black), with standard deviations (grey).