Limb Strength and Limb Dominance in a Step Forward to Standing Task

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Introduction
The majority of locomotion research has focused on analysis of straight, over ground walking which may not be adequate to define activities of daily living.

Populations with clear between-limb functional deficits (such as unilateral lower extremity amputation) alter strategies to initiate with less functional limbs and terminate with more functional limbs [1,2].

This work aimed to determine if neurological preference for selecting an initiation limb is associated with limb strength or reported limb dominance in a young, able-bodied population.

Due to published initiation preference of those with between limb functional deficits and previous able-bodied termination knee loading analysis, it was hypothesized that

• H1) Limb strength and limb dominance would correlate with the second limb to step forward.
• H2) At gait termination, the loading of the first limb to step would be greater than what was experienced by the second limb.

Methods
62 healthy adults participated after completing IRB approved informed consent procedures.

Table 1. Participant demographics

<table>
<thead>
<tr>
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<th>Male (n=27)</th>
<th>Female (n=35)</th>
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</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>21 (3)</td>
<td>21 (5)</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>75.6 (13.9)</td>
<td>62.7 (7.9)</td>
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<tr>
<td>Height (m)</td>
<td>1.79 (0.06)</td>
<td>1.66 (0.06)</td>
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<tr>
<td>Limb length* (m)</td>
<td>0.83 (0.04)</td>
<td>0.79 (0.05)</td>
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*R length was defined as the vertical height of trochanter marker

Limb dominance was defined as the preferred kicking leg reported by participants.

An isokinetic dynamometer (Biodex Medical Systems, Inc., NY, USA) was used to measure three repetitions each of maximum voluntary isokinetic (180°s⁻¹) knee flexion and knee extension for each participant. The limb which produced greater peak extension torque was classified as the stronger limb.

One motion capture trial (13 cameras, Vicon Inc.; Oxford, UK) was collected as participants stood with feet “about shoulder-width apart” and took two steps forward onto two embedded force platforms (Kistler, NY, USA).

Kinematics (200Hz) were collected simultaneously with analog data (1000Hz) and were filtered with a 4th order, zero lag Butterworth filter at 6 Hz and 50 Hz, respectively.

Temporalspatial outcomes and kinetic peaks were analyzed in Visual3D software (C-Motion, Inc.; Germantown, MD, USA).

Statistical analysis was performed in SPSS software (IBM Corp.; Armonk, NY, USA; Version 23) all p ≤ 0.05

Results

Average (SD) step length was 0.39 (0.06) m and stance width was 0.17 (0.01) m

• 59.7% of participants had dominant limbs which were the stronger limb (quadrants I & III in Figure 1). However, limb dominance was not associated with limb strength (p = 1.00).
• 45.2% of participants initiated with the stronger limb (quadrants I & II in Figure 1); limb strength was not associated with limb selection (p = 0.43).
• 46.8% of participants initiated with their dominant limb (quadrants II and III in Figure 1); limb dominance was not associated with limb selection (p = 0.12).

Between-limb extension torque deficits were not different between groups of participants that took the first (yellow) or second step (red) with the stronger limb (p = 0.72; Figure 1).

Conclusions

Contrary to H1) no association was found between limb strength or limb dominance and the limb preferred to start or stop a step-to-stand movement

• Suggests that the central nervous system does not have an initiation preference related to limb dominance or limb strength

Results aligned with H2) loading of the first limb to step was greater than what was experienced by the second limb

• Suggests that populations with clear initiation preferences could experience altered loading patterns.

Future research should investigate if increased joint loading is seen on the initiating limb of those with unilateral injury

References

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