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# Ankle dorsiflexion range of motion asymmetry does not influence landing forces during a bilateral drop-landing

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## INTRODUCTION

Ankle dorsiflexion range of motion (ROM) has a reported relationship ( $r = -0.31$ ) with peak vertical ground reaction forces (vGRF) during landing activities, with higher peak vGRF produced among those with the greatest ROM deficit.<sup>2</sup> The commonly reported inter-limb asymmetries in ankle dorsiflexion ROM among healthy populations<sup>5</sup> and athletes<sup>3</sup> are therefore, likely to influence the kinetic landing profile. However, the relationship between inter-limb asymmetry in ankle dorsiflexion ROM and the loading strategy utilised during landings has not yet been investigated.

## AIM

The purpose of this investigation was to assess the relationship between asymmetries in ankle dorsiflexion ROM and kinetic variables associated with bilateral drop-landing performance.

## METHODS

Forty-eight healthy and physically active volunteers (27 men, 21 women; age =  $22 \pm 4$  years; height =  $173.0 \pm 10.9$  cm; mass  $71.7 \pm 15.3$  kg) reported to the laboratory for a single testing session. Participants performed the weight-bearing lunge test (WBLT) three times for both legs, with ankle dorsiflexion ROM recorded in degrees using the trigonometric function.<sup>4</sup> Participants then performed five bilateral drop-landings from a 45 cm box located 15 cm away from the target landing area, with 60 s recovery between trials. Two single axis force platforms (Pasco, Roseville, CA, USA), recording at 1000 Hz, were used to measure vGRF for the left and right legs simultaneously. vGRF data were low-pass filtered using a fourth-order Butterworth filter with a cut-off frequency of 50 Hz, with normalised peak vGRF, time to peak vGRF and loading rate (LR) calculated bilaterally and normalised peak vGRF calculated unilaterally for each limb (Figure 1). Asymmetry scores for the WBLT and peak vGRF during bilateral drop-landings were calculated using the percentage difference and bilateral asymmetry index 1 method, respectively.<sup>1</sup> To determine the direction of asymmetry, a positive value was arbitrarily assigned to right leg dominance, while a negative value indicated left leg dominance. Relationships between asymmetries in the WBLT and peak vGRF, time to peak vGRF, LR and asymmetries in peak vGRF were assessed using Pearson's correlation coefficient, with the a-priori level of significance set at  $P < 0.05$ . Ethical approval was provided by the Research Ethics Panel at the University of Cumbria.

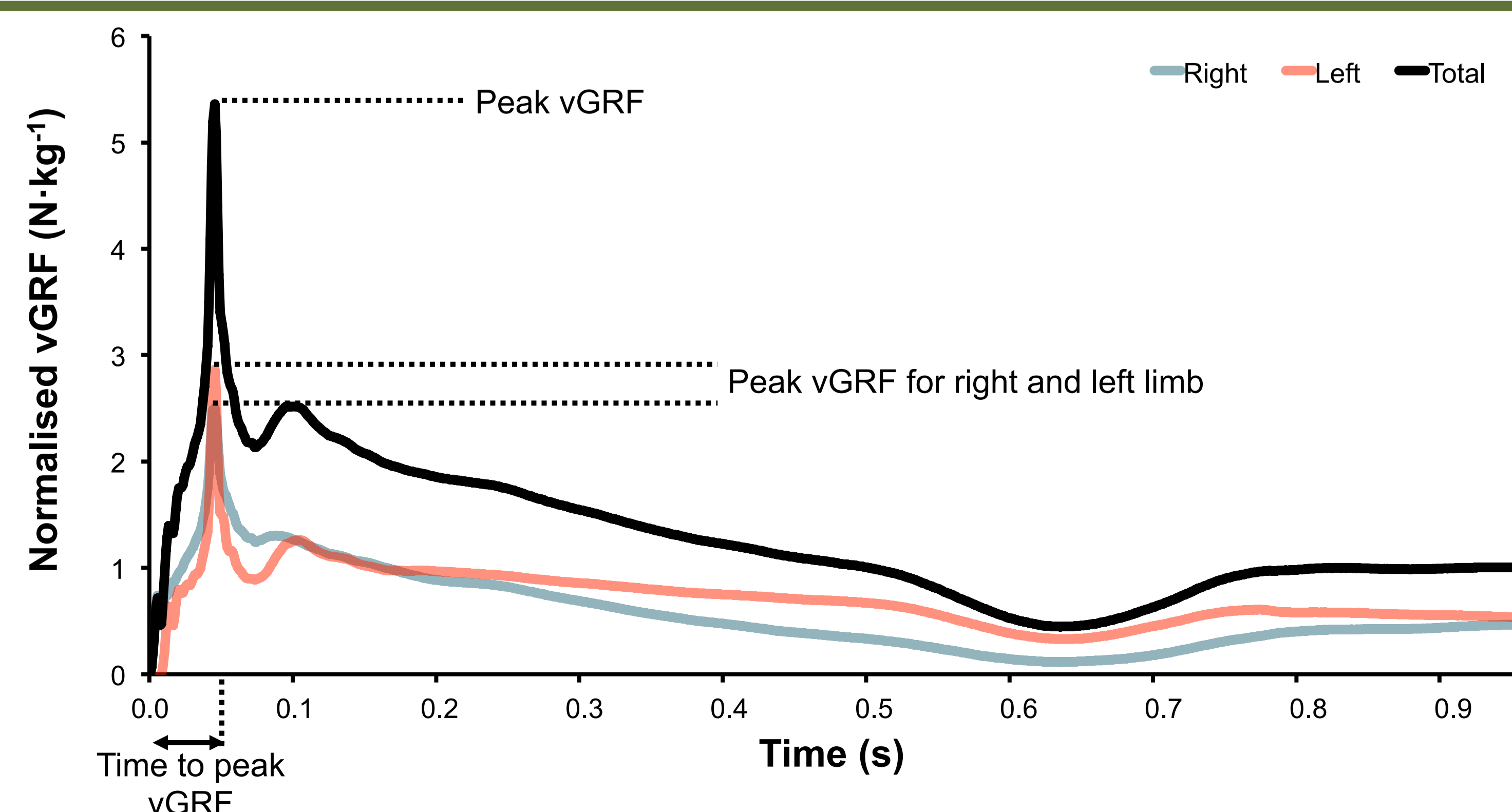


Figure 1. Example force-time data for bilateral drop-landings.

## RESULTS

The mean inter-limb asymmetry scores for the WBLT was  $-2.1 \pm 6.7\%$  across all participants. Average peak vGRF, time to peak vGRF and LR was  $3.98 \pm 1.16$  N·kg<sup>-1</sup>,  $0.055 \pm 0.011$  s and  $79.0 \pm 34.8$  N/s, respectively. Furthermore, mean inter-limb asymmetries in peak vGRF was  $6.8 \pm 8.8\%$ .

Table 1 presents all correlations. The relationship between asymmetries in the WBLT and peak vGRF, time to peak vGRF and LR during the bilateral drop-landing was non significant. Similarly, there was no significant relationship between asymmetries in the WBLT and inter-limb asymmetries in peak vGRF.

**Table 1.** Correlations between inter-limb asymmetries in ankle dorsiflexion ROM during the WBLT and kinetic variables associated with bilateral drop-landing performance.

Kinetic variable	<i>r</i>	<i>P</i> value
Peak vGRF	-0.08	0.61
Time to peak vGRF	-0.22	0.13
Loading rate	0.01	0.95
Asymmetry in peak vGRF	0.12	0.43

## CONCLUSIONS

The findings from this investigation suggest that asymmetries in ankle dorsiflexion ROM do not influence the kinetic loading strategies associated with bilateral drop-landings. Furthermore, this investigation indicates that factors other than ankle dorsiflexion ROM asymmetry are likely to determine asymmetries in vGRF detected during bilateral landing tasks. Further research is required to identify the movement strategies that are adopted by athletes with asymmetrical limitations in ankle dorsiflexion ROM to allow for compensation during landing activities.

## KEY POINTS:

- **Inter-limb asymmetries in ankle dorsiflexion ROM unlikely influence kinetic variables associated with bilateral drop-landing performance.**
- **Asymmetries in peak vGRF during bilateral drop-landing are not driven by inter-limb differences in ankle dorsiflexion ROM.**

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